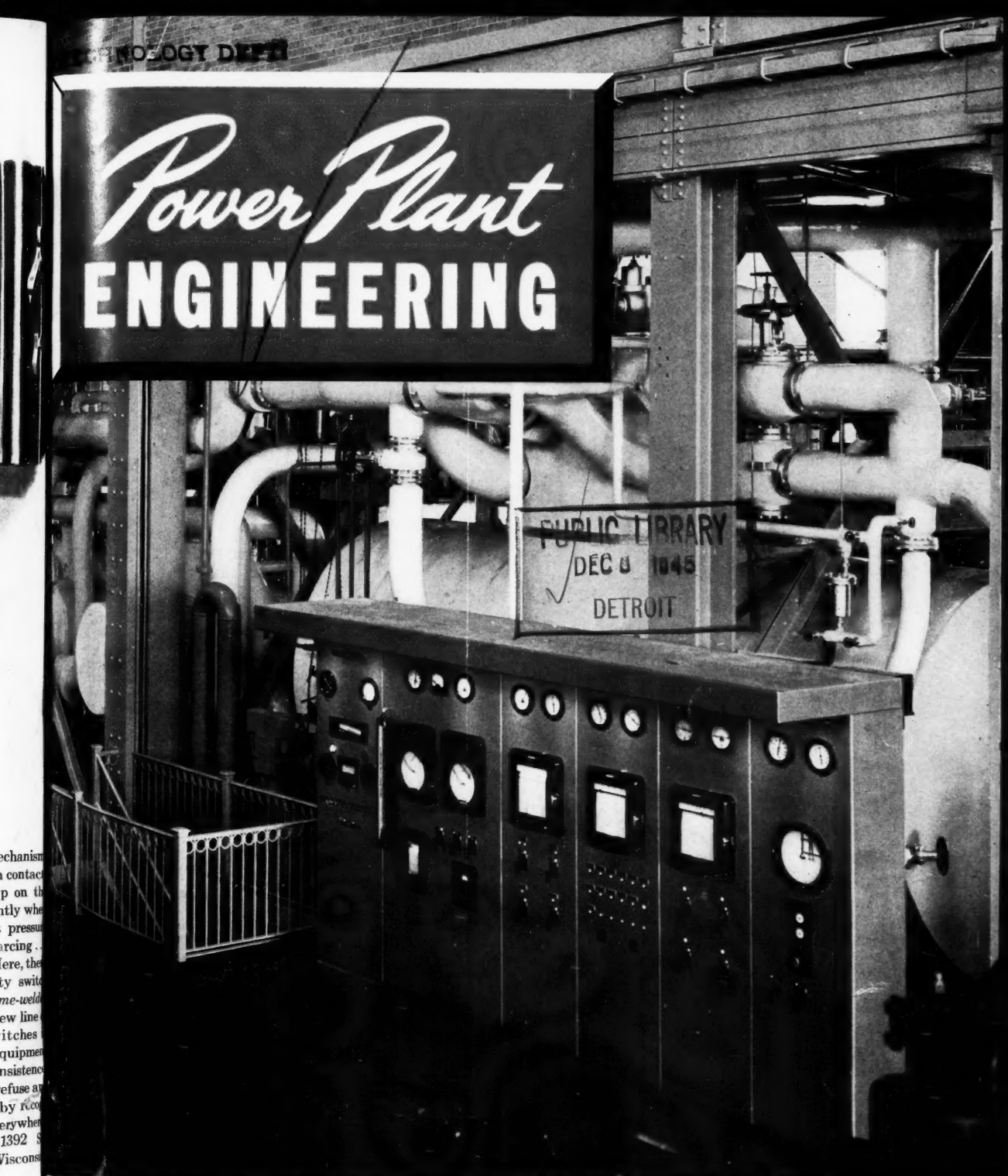


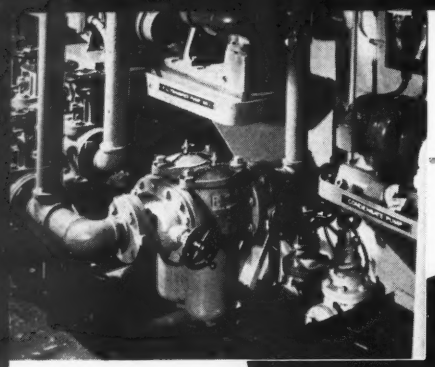
POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

NOVEMBER • 1945

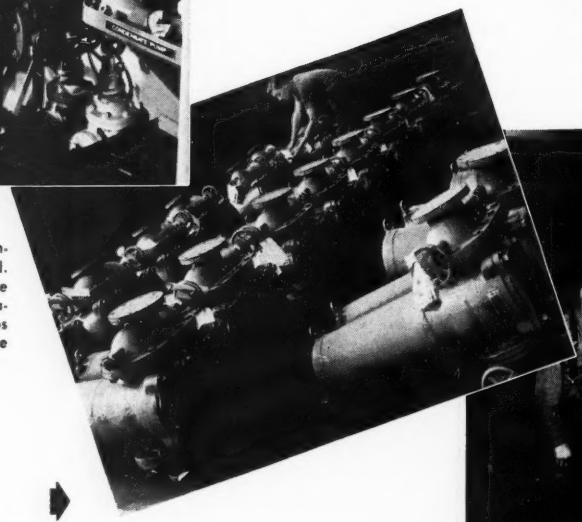
Features

TOPPING AT HELL GATE · THE APPLICATION OF POWER LINE CARRIER · BURNING WOOD WASTE · THE DEVELOPMENT OF ATOMIC ENERGY · CONTINUOUS FLOW CONVEYOR · BURNING TAR UNDER POWER BOILERS · · · CONTENTS PAGE 5

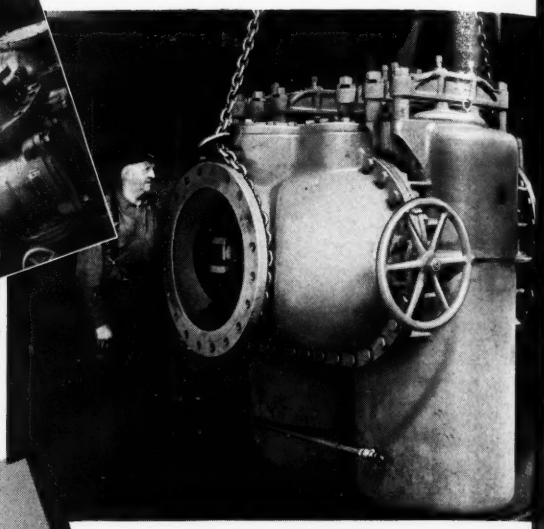
Front-line



Typical Elliott strainer installation on shipboard. Thousands of these are proving their indispensable qualities in warships of all types and Maritime Commission vessels.



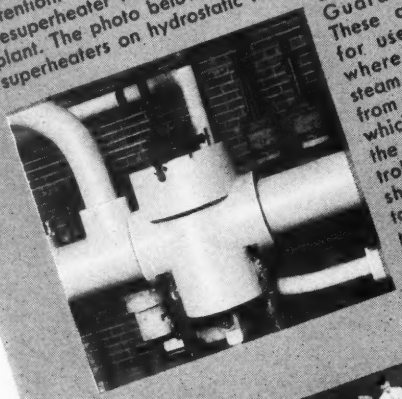
A group of marine type strainers being checked for shipment.

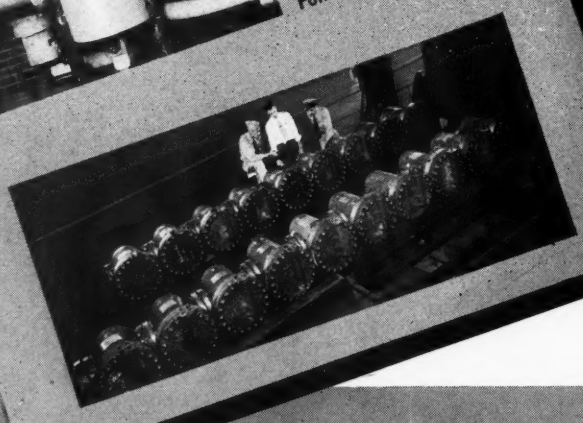


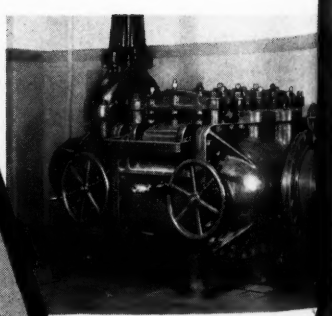
They come large. This is an Elliott 24" Twin Strainer, for constant service. While one strainer basket is removed for cleaning, the twin basket takes on the load. No time-out, no let-up in service.

ELLIOTT DESUPERHEATERS

take the superheat out of steam, dependably and without attention. The picture at left shows a close-up of an Elliott desuperheater with pressure reducing station in a power plant. The photo below illustrates a group of Elliott desuperheaters on hydrostatic test receiving final okay by Elliott and Coast Guard inspectors. These are intended for use on tankers where they reduce steam temperatures from 750 to 500°F., which is safely below the flash point of petroleum products. All ships in the entire tanker program are protected by these Elliott desuperheaters. Full details on request.







Another type of Elliott Twin Strainer. This is a 16" job, in a public utility station. Pressure gage tells when a strainer basket needs cleaning.

STEAM TURBINES • GENERATORS

MOTORS • CONDENSERS

FEEDWATER HEATERS AND DEAERATORS

TECHNOLOGY DEPT.

...essentials in plant operation

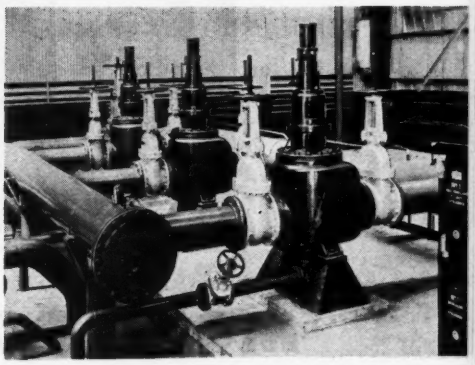
ELLIOTT STRAINERS

There are larger and more spectacular units in the power plant than strainers—but none more essential. Ashore or afloat, their job is vital.

Elliott strainers make liquids safe—service water, cooling water, lubricating oil, fuel oil. They stop any foreign matter or sediment that gets past trash racks or into oil supply. They individually protect water-using apparatus, pumps, valves, bearings, pistons, burner nozzles. And in the process industries their function is even broader.

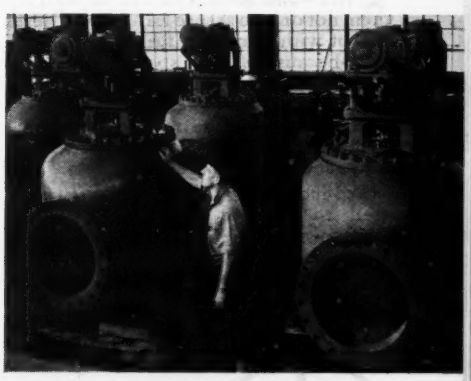
From the single strainer with one basket, to the self-cleaning unit that needs no attention, Elliott strainers are made in all required types and sizes, and are in service by the thousand.

Have you a problem concerned with the clearing of liquids? Call upon "Strainer Headquarters".



Elliott Self-Cleaning Strainers in a steel mill. Widely used for taking quantities of relatively fine dirt from water. A central element revolves constantly, isolating in turn various strainer sections which are flushed clean by back-flow of a small part of the incoming water. No attention required.

Below, large self-cleaning strainers waiting their turn on the test floor.



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STEAM JET EJECTORS • CENTRIFUGAL BLOWERS
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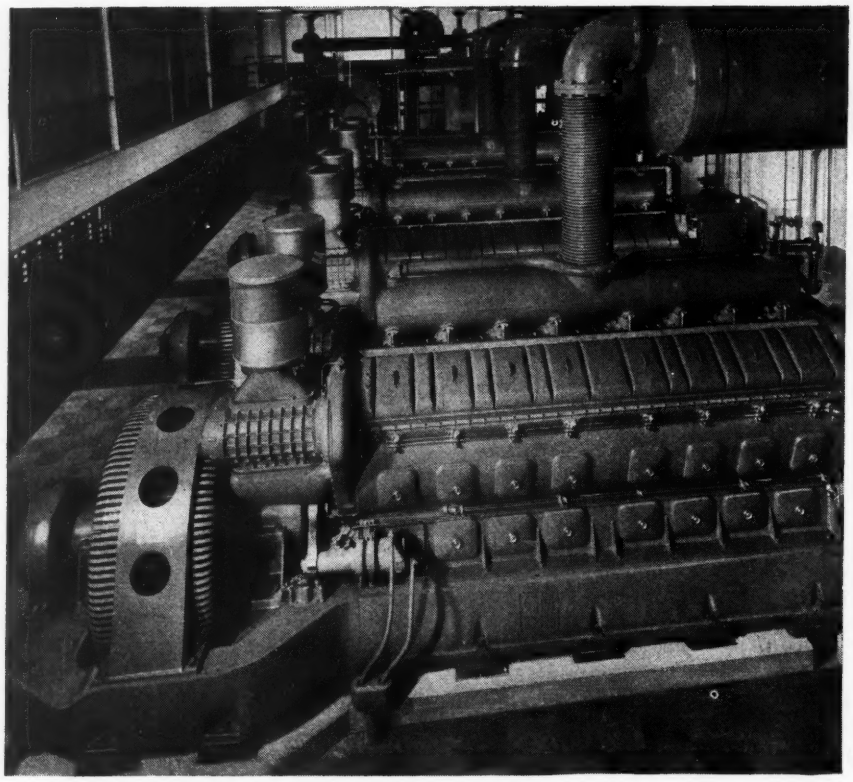

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when you lubricate Diesels with oil that...

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- ★ Assures piston seal, full compression
- ★ Prevents scuffing, greatly reduces wear
- ★ Keeps engines clean

TEXACO Ursa Oils have all these qualities—*and more!* You can depend on them not only to assure full-power Diesel output with minimum fuel consumption but—because of their special properties—to prolong the life of bearings, liners, rings and pistons. Their use means extra thousands of hours of trouble-free service between overhauls. You save materially on your Diesel maintenance costs.

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TEXACO Ursa Oils

FOR ALL DIESEL ENGINES

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Power Plant ENGINEERING

November 1945

VOLUME 49—NUMBER 11

Cover: Turbine generator control panel in the turbine room of the Florida Power Corp. plant in St. Petersburg. The panel is made of steel plate and designed with a canopy containing recessed lights. Mounted on the panel are instruments and controls for the reducing and desuperheating station, generator field and stator temperature recorders, conductivity recorder, turbine steam flow, temperature and pressure recorder, stage pressures, mercury column, and speed and cam shaft position indicator.

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Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

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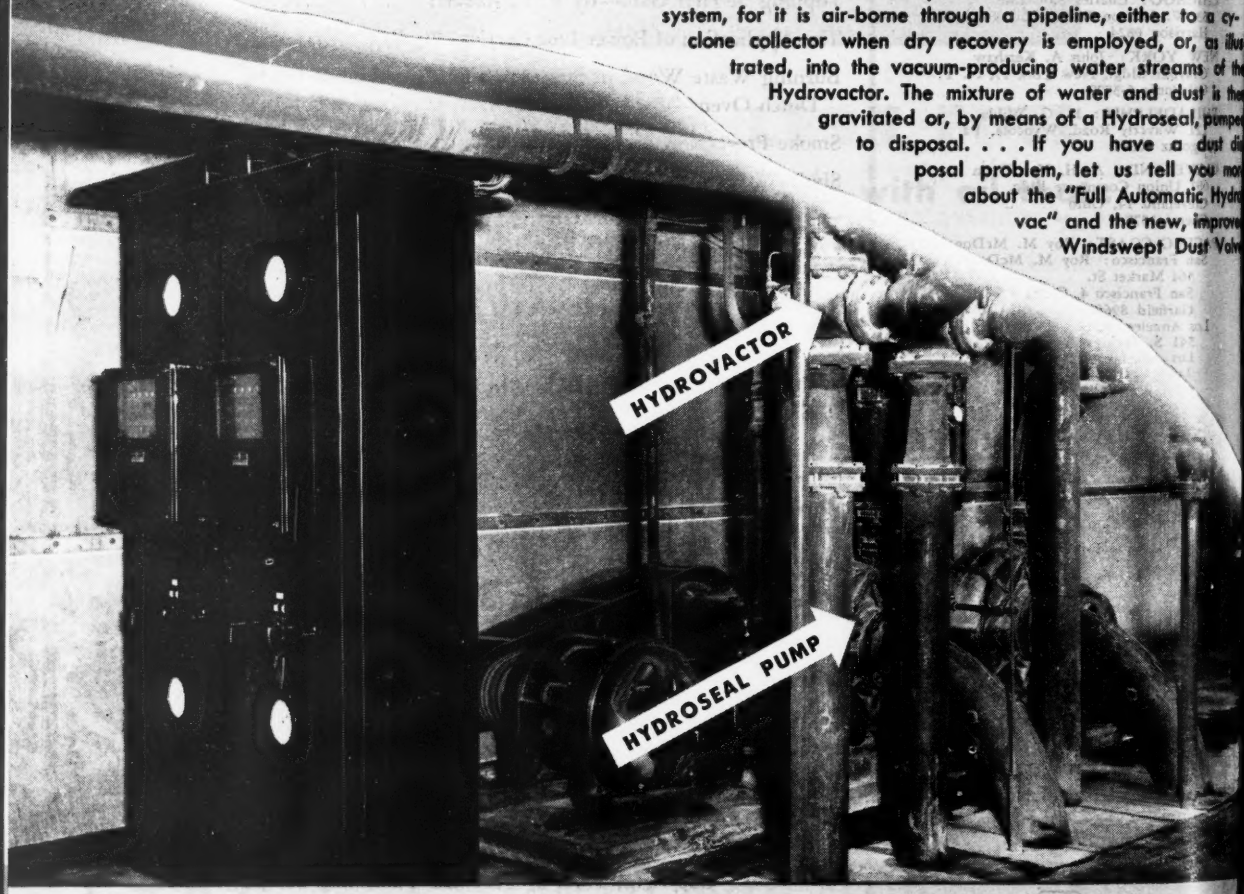
With the "Full Automatic" Hydrovac Dust Handling System, the mere throwing of a switch (a one-handed job), on the remote control operating panel, starts the removal of dust from various hoppers throughout the plant. One Windswept Dust Valve after another opens, feeds dust and closes, and when the last hopper is clean, the system automatically shuts down. Signal lights on the control panel show which hopper is being emptied of dust. . . . No labor for attendance is required. Dust cannot escape from the system, for it is air-borne through a pipeline, either to a cyclone collector when dry recovery is employed, or, as illustrated, into the vacuum-producing water streams of the Hydrovactor. The mixture of water and dust is then gravitated or, by means of a Hydroseal, pumped to disposal. . . . If you have a dust disposal problem, let us tell you more about the "Full Automatic Hydrovac" and the new, improved Windswept Dust Valve.



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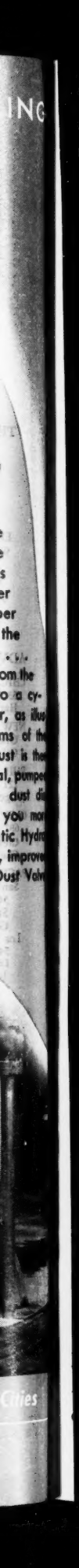


Front Lines—

DAN GUTLEBEN (see A good Engineer Steps Down, PE & E, May 1945, page 102) following out his announced plan to cross the country, visiting old friends and collecting more data for his book on the sugar industry, gradually worked his way West and, after many pleasant detours, drove into Chicago one day last July. After a visit with us, to our great enjoyment and profit, and some trips to local plants, he continued his journey on a carefully-calculated allowance of gasoline. (This was while rationing was still in force, requiring special OPA permission.) Like the good engineer he is, Dan finally arrived in California, late in August, with a surplus of 90 gal of the precious fluid. But O-o-o-h!—irony of fate!—snickering of the Gods on Olympus!—the day after he arrived, he wrote, gasoline rationing was eliminated. If he had put into his letter what he really thought, we imagine it could have been substituted for the atomic bomb. He also sent the following letter for J. A. Jacobs, typical of the sort of act that has won him so many friends.

Dear Mr. Jacobs:

I have read in the June issue of Power Plant Engineering (Front Lines, page 7) that you are a collector of covered bridge lore. I have never collected any bridge traditions but have many times feasted my eyes on old covered bridges while I lived in Philadelphia—where until recently I was chief engineer of the Pennsylvania Sugar Co. I recall also that I made a picture of a covered bridge near Guelph, Ontario about 30 years ago.

My special interest in covered bridges just now is the fact that my friend Fred C. Williams of Lincoln, Nebraska, is pursuing a hobby like yours. He is growing old like some of the rest of us and so he is not able to travel vigorously to search out the famous old landmarks. To make things a little more interesting for him, I am trying to locate a book on "Covered Bridges" which was reviewed in Engineering News a number of years ago. I have forgotten the title and the year of publication but the impression is that the book was liberally illustrated and was written for the edification of the layman rather than the engineer. I have requested the publishers to make a search for the book.

If you can make some suggesitons, I would be grateful.

As to the brain teaser, in the last paragraph of the Front Lines item, I have to admit that I am slipping. My friend Montgomery Case, who was the construction engineer on Modjeski's Delaware River Bridge, was the boss in the field on the George Washington Bridge. New York developed Lillienthal, Moissief, Waddell, Modjeski, Steinman, and many other great bridge engineers—the pattern having been set by Roebling.

I don't remember who designed the Pulaski bridge but I believe McClintic Marshall furnished most of the steel.

About ten years ago, while I was driving over it, my wife's silk coat blew out of the car window. During a wide gap in the traffic, I made a U turn, retrieved the coat and am probably the only man on earth who ever did this. If the traffic cop had caught me, I would probably be in Sing Sing even yet!

I know Waddell because of his inspiring discourses to the students at the University of Nebraska and because of his apology in the preface of the 2nd edition of his handbook "De Pontibus." He explained that he had used Latin for his title to somehow justify his long years of study of this language.

The Golden Gate Bridge of course points to Straus and Derleth and the consultants from New York. But Straus' outstanding impression on my mind is his beautiful poem about the majestic redwoods. All I can claim on your question is 30 per cent!

Sincerely,

DAN GUTLEBEN

DETAILS of the various steps employed in making Fiberglass, with fine photographs of the important operations, are given in Compressed Air, Vol. 50, No. 8.

AMBITIOUS AL, our engineer friend who is always sounding off, says he noted with much interest the design of the "memex" by Dr. Vannevar Bush reported in August Front Lines. This device, you remember, would contain on microfilm a record of all the information available on various subjects, with tabulating and selecting devices to enable you to trace a trail of information on a given subject by association of ideas, as you actually do it in practice, instead of by the present unwieldy method of subject indexes. One defect in that scheme, says Ambitious Al, is that after you had collected all the data by association of ideas, you would still have to read it. And you would be thunderstruck to discover how much of it was unadulterated schmalz—distilled bilgewater—balloon juice, Grade A—in a word, "bull." (Dr. Bush himself also pointed out this difficulty.) Ah! but Ambitious Al forgets. We *have* a device designed for the express purpose of eliminating the "bull." This is the oxometer, noted in Front Lines, April 1944. A combination of the memex to correlate the dope and the oxometer to eliminate the "bull" from the resulting agglomeration—there you'd really have a gimmick!

THE NAVY hurled its carrier-based bombers and fighters against the Japs by means of a unique "deck-edge" elevator that whisks planes up the outside of the ship to the flight deck in a matter of seconds, it was revealed recently. Now being installed on the Navy's new fleet of "Midway" class super-carriers, these unorthodox new Westinghouse elevators have secretly been in battle service for two and a half years on the 27,000-ton Essex-class fleet in every major task force operation in the Pacific.

WANT MORE EDUCATION to help in your post-war job, to study for an advanced degree, to keep up with latest developments or review fundamentals in a particular field, without working for a degree? Better begin now; in four or five years you may wish you had. Already things are loosening up. Get in touch with the engineering college nearest you or one in which you are particularly interested. They are all working on the problem. Some of them have already come up with some answers that should interest not only the ex-GI but also the home front veteran looking for a ladder. F'rinstance—Case School of Applied Science announces a whole series of undergraduate and graduate courses in the evening division: algebra and trig, physics and chemistry, English and on up the line to heat power engineering, quality control, instruments and automatic control, and so on. Other engineering colleges will follow suit as soon as they can get organized. Don't forget—education is something you've got to do to yourself. The college course can show you the way. But only you can do the work that gives you the education. And it merely begins with "taking a course." You've got to keep on giving it to yourself all the rest of your life.

JET PROPULSION is not new; neither is it the invention of "the supercreative German mind," Charles Owen Brown, New York consulting engineer, says in Industrial and Engineering Chemistry. During the First World War, he says, a Niagara Falls engineer proposed the development of jet-propelled military planes, but his proposal was "filed" in favor of the Liberty motor.

TO MAKE AN extensive sea water corrosion test a total of 240 test pieces of copper alloys, of widely varied composition, was exposed to clean flowing sea water (60 to 90 cm per sec) for periods of six and twelve months, during which the water temperature ranged between 2 and 30 C. In general it is concluded that in the case of copper alloys, slight modifications of these alloys by the addition or subtraction of minor constituents of the alloys, will in many cases, greatly affect their corrosion resistance to clean flowing sea water. Complete details of the tests are given in an article by C. L. Bulow, entitled, Corrosion and Biofouling of Copper-Base Alloys in Sea Water, in Transaction of the Electrochemical Society, Volume 87, 1945.

DRY ICE LIQUEFIER, which transforms solid carbon dioxide into the liquid form, has been developed by The Mathieson Alkali Works to assist users of carbon dioxide fire extinguishers, and other carbon dioxide consumers. To charge the unit, 20 full-sized blocks, or 1,000 lb, of dry ice are dropped in at the top, it is then closed, water is run down the outside surface from a perforated ring near the top, and the liquefier is ready for operation.

ALTHOUGH LITTLE KNOWN as a war baby the United States production of lithium, lightest of all solid elements, has increased seven fold during the war, says the industrial bulletin of Arthur D. Little, Inc. The price of lithium metal, $12.50 per pound in large lots, has not dropped greatly, but some manufacturers predict that with new production facilities and the hoped-for large postwar demand, a price of $5.00 may be possible. An important wartime product has been a lithium compound which on addition of water releases the hydrogen gas used to inflate balloons for carrying aloft radio antennae and signals from life rafts at sea. Solutions of lithium chloride or bromide have been used for absorbing moisture in air drying and may have many industrial and domestic applications. Although lithium is not rare, commercial deposits are few, and up to the present, methods of extraction have been difficult and costly. The wartime expansion of production gives lithium producers a real opportunity to develop outlets in postwar markets.

INDUSTRY OPINION on Proposed Science Legislation, a survey made by the Smaller War Plants Corp. for the Subcommittee on War Mobilization of the Committee on Military Affairs, United States Senate has just been published as Subcommittee Monograph No. 4, and is available from the Superintendent of Documents, United States Government Printing Office, Washington, D. C.

SOCIAL OUTCASTS who do not use the correct form of underarm deodorant or the correct tooth paste or the correct clove-flavored chewing gum are completely eclipsed these days by the unfortunate wight in engineering or science who did NOT work on the atomic bomb. This writer can be rescued from the oblivion and ostracism suffered by such non-atomic wights only by one single quantum of reflected glory, originating many light-years away in his youth. This writer, when a sophomore at Tufts Engineering School, was a member of a mathematics class taught by a tall young man known as "Van" Bush. You guessed it. That same "Van" Bush is now Dr. Vannevar Bush, recently Director of the OSRD, president of Carnegie Institution, etc., etc., etc. So the writer thinks he can claim that he once "studied under" Dr. Bush. Not good enough? Ah, well, we were afraid it wouldn't be.

ONE OF THE most common materials we see about us every day is brick. Yet the only thing that most people know about brick is that once the Egyptians ordered the Jews to make it without straw. However, the modern methods of making brick are vastly different from that and if you are interested in the details, you should read the article entitled, "Bricks Are Alive This Day," by Darrel Doolen, in the October, 1945, issue of the Central Manufacturing District magazine. It is the only article we have seen that describes the brick making process in detail as it is actually carried on at the present time.

DEVELOPMENT OF A NEW hot plastic anti-fouling paint for the hulls of ships, is expected to enable the United States Navy to lay up many ships after this war in dry storage. A new chemical packaging process called strippable coating to protect deck equipment exposed to the elements has also been devised. The big problem, of course in laying up war ships is to prevent the effects of moisture. An interesting account of how this is done is given in the November 3 issue of Liberty magazine.

THE MICROFLASH, originally developed for research work at the beginning of the war, is now available for peace time use in research work where short photographic exposures or flashes of light are required. It provides a means of photographing objects in much faster motion than was possible with equipment designed primarily for stroboscopy. It provides a flash of about 2 microseconds.

THE WATERY EYES and wheezing which bother victims of airborne pollen in late summer, effected Daniel S. Gustin, manager of lamp engineering for Westinghouse so much that he installed a Precipitron electrostatic air cleaner in his home to get some relief. As his wheezing subsided he watched the dirt gather on the charged plates, and wondered if this principle could be used to coat the inner glass of the tubes used for fluorescent lamps. As a result of his observation the powders that now coat the inner wall of a fluorescent lamp are being applied by electronic methods from a cloud of phosphor dust.

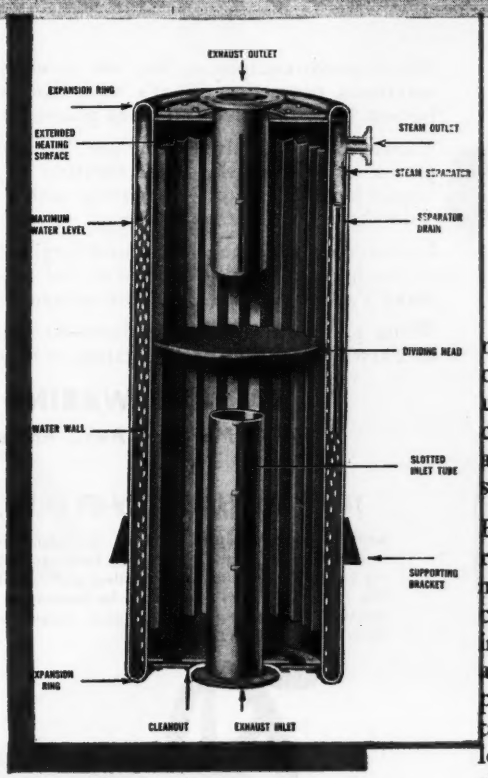
SAVE FUEL

PUT EXHAUST HEAT TO WORK WITH

MAXIM HEAT RECOVERY SILENCERS

There are few industrial plants that would knowingly throw away fuel, and yet many do just that when they allow engine exhaust heat to escape without making use of it. Maxim Heat Recovery Silencers utilize exhaust heat to produce steam or hot water for heating or processing operations. They combine in one unit effective silencing of exhaust noise, spark arresting (where necessary) and efficient heat recovery.

From an efficiency point of view, the value of using Maxim Heat Recovery Silencers is obvious. Engine exhaust must be silenced as a matter of good public relations. The use of Heat Recovery Silencers accomplishes this and, in addition, produces "fuel-free" steam or hot water.



For silencing without the heat recovery feature, Maxim makes silencers for internal combustion engine exhaust or intake, steam engine exhaust, air compressor intake, vacuum pump discharge, blower intake and discharge, high velocity steam, air or gas discharge. Engine exhaust silencers available with or without spark arrestor. Bulletins on request.

Write for Bulletin

Bulletin WH-101 is an eight page illustrated folder showing various types of heat recovery silencers and also practical working hook-ups. A copy will be sent promptly on request.

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ARMY ★★ E ★★ NAVY

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for Dependable Power Plant Protection

Major steam equipment, and the investment it represents, should have maximum protection. That's why, from overhead water level gages to bottom blow-off valves, so many plants insist on Yarway auxiliaries.

Yarway blow-off valves alone are "standard" equipment in over 12,000 plants today. And the latest addition to the Yarway line—the Remote Liquid Level Indicator—is proving such a success that already more than 3,000 have been purchased.

Unswerving adherence to sound engineering principles, plus constant research in anticipation of new and more rigid service requirements, make Yarway products a fine investment in boiler protection.

When planning new installations—or extending present facilities—look to Yarway for boiler trim. Catalogs available on request.

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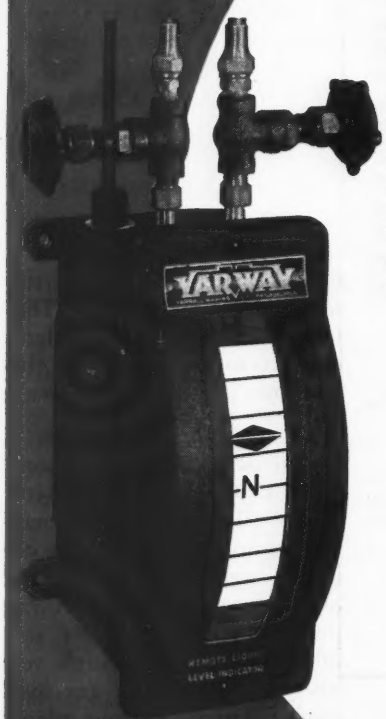
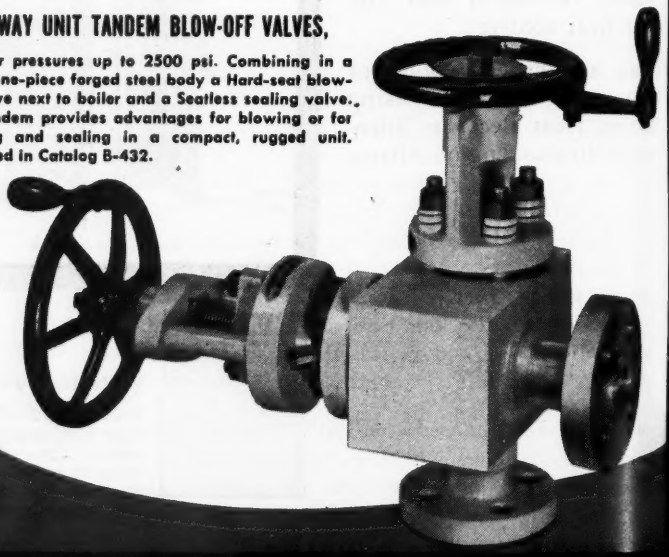


YARWAY REMOTE LIQUID LEVEL INDICATOR,

for pressures up to 1500 psi. Brings boiler water level indication down to instrument panel or other convenient eye-level location—right in front of your eyes, on a brilliantly lighted scale. Operated by the boiler water itself, using the pressure differential between a constant head of water and the varying head in the boiler drum. Described in Catalog 1[illegible]-1500.

YARWAY UNIT TANDEM BLOW-OFF VALVES,

built for pressures up to 2500 psi. Combining in a single one-piece forged steel body a Hard-seat blowing valve next to boiler and a Seatless sealing valve., This tandem provides advantages for blowing or for draining and sealing in a compact, rugged unit. Described in Catalog B-432.

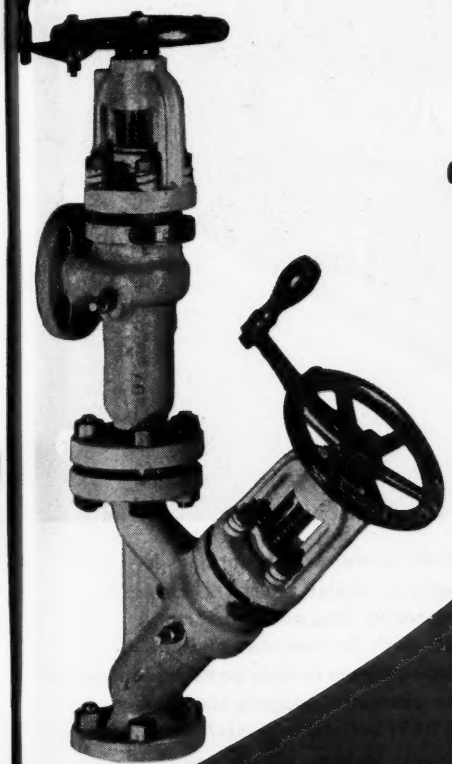


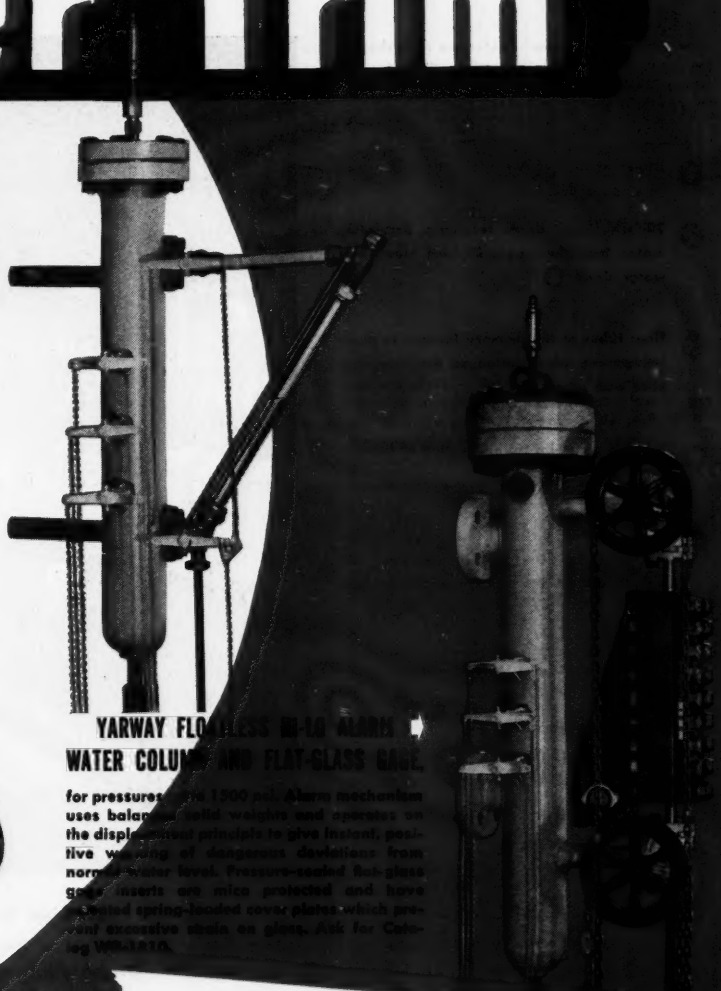
YARWAY STEAM PLANT E

Boiler Trim

YARWAY FLOATLESS HI-LO ALARM WATER COLUMN WITH SESURE INCLINED GAGE,

for pressures up to 400 psi. Water column operates on same principle as the high pressure column. Sesure inclined gage gives easy reading of water level from below. Described in Catalog WG-1810.





YARWAY FLOATLESS HI-LO ALARM WATER COLUMN AND FLAT-GLASS GAGE,

for pressures up to 1500 psi. Alarm mechanism uses balanced solid weights and operates on the displacement principle to give instant, positive warning of dangerous deviations from normal water level. Pressure-sealed flat-glass gage inserts are mica protected and have spring-loaded cover plates which prevent excessive strain on glass. Ask for Catalog WG-1810.

YARWAY SEATLESS TANDEM BLOW-OFF VALVES,

standard in over 12,000 plants—for pressures up to 400 psi. Features balanced sliding plunger design with non-clogging, straight-through flow. No seats to cause wear and leak. Described in Catalogs S-434 and S-435.

SEE YARWAY PRODUCTS . . . HEAR LOWELL THOMAS DESCRIBE

their design, application and maintenance in the colorful, informative, 30-minute Kodachrome and sound motion picture, "There Is An Engineering Reason."

Follow Yarway equipment into great power plants, oil refineries, rubber mills, processing plants and other industries. Lowell Thomas, the world-famous commentator, is your narrator.

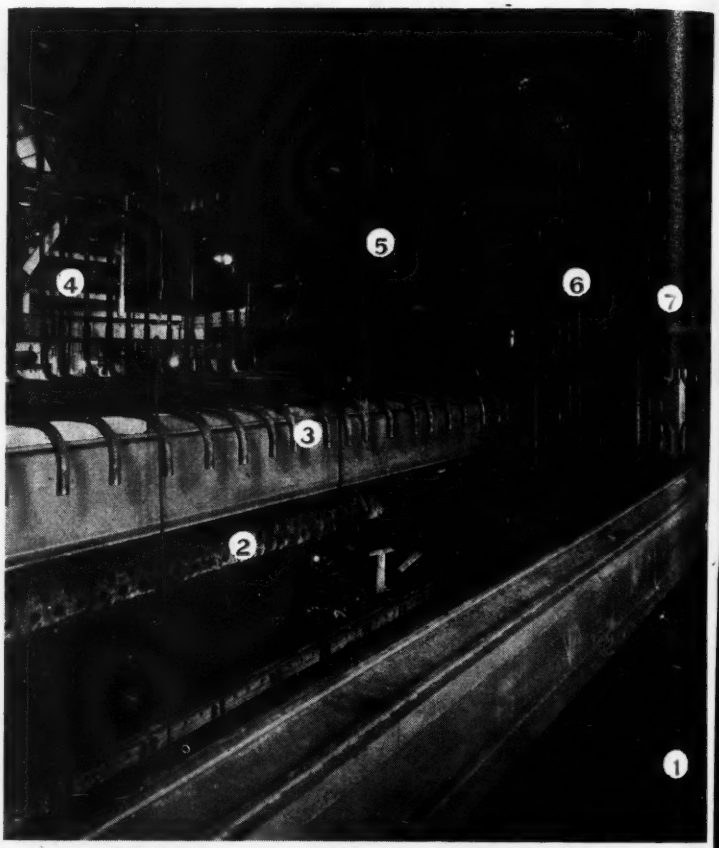
Technical societies, employee groups, engineering schools and colleges may obtain this film without charge. Write for further information today.

T EQUIPMENT

2 MORE* MILLION-POUND

Photographs taken during erection give shape to, and help clarify, the setting drawing of these B&W Open-Pass Boilers shown on the opposite page.

1. Lower header of rear wall and baffle wall
2. 30-inch lower drum receiving circulating water from the upper 72-inch steam-and-water drum 8
3. Floor tubes of the primary furnace in place —these are continuation of the front furnace wall tubes
4. Tubes in place for burner section of furnace front wall
5. Fully studded section of primary furnace in combustion zone—when completed, this section will be covered by plastic chrome ore
6. Tangent bare tubes in side wall of open-pass section of furnace
7. Bare tubes with flat studs between in lower section of side wall in open-pass section of furnace



TO EXPAND system capacity and improve fuel economy, the Consolidated Edison Company of New York is now installing a 65,000-Kw. topping turbine and two B&W 1,000,000 lb.-per-hour Open Pass Boilers at its Hell Gate Station, world's second largest steam power station.

These boilers are being installed in the floor space formerly occupied by twelve stoker-fired, straight-tube, 275-psi units, and will deliver nearly twice as much steam per hour as the twelve units they replace.

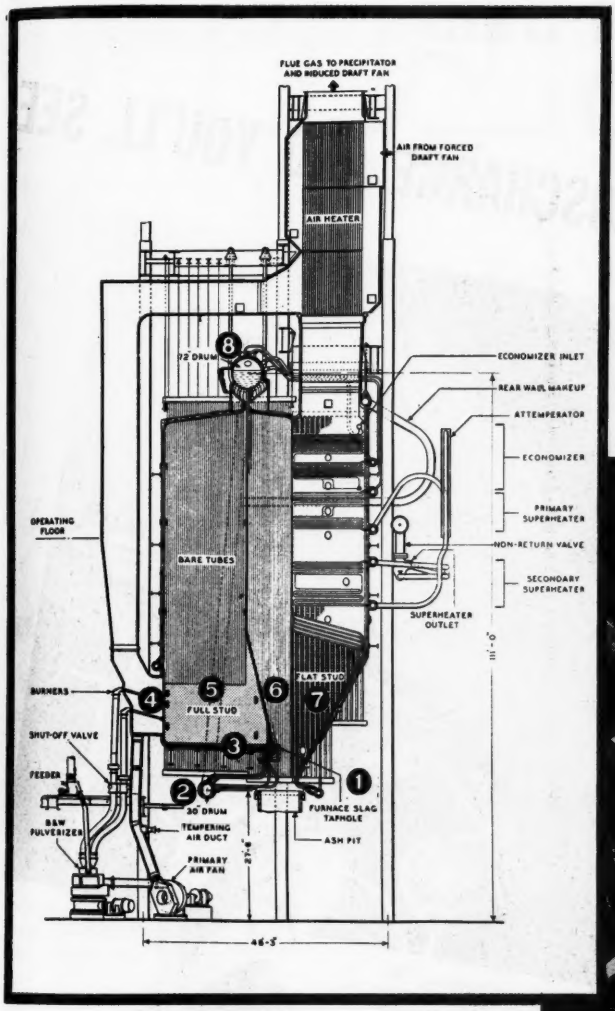
The new steam generators are designed for pulverized-coal firing in slag-tap furnaces. These and other features are shown by the drawing on the opposite page.

This Hell Gate modernization project is another example of boiler selection being strongly influenced by long and satisfactory past experience with the economy and efficiency of B&W equipment. It is patterned after a similar successful topping installation including B&W boilers, at Consolidated Edison's Waterside Station.

B&W has been successfully serving the nation's electric light and power industry since its very beginning . . . designing, fabricating, and applying steam-generating equipment for every combination of operating conditions. This broad experience is at your disposal now in building tomorrow's efficiency into today's steam power plants.

* Two other million-pound B&W Boilers have been in service in this plant since 1930, tests of which are given in ASME paper presented by W. E. Caldwell, June, 1933, "Characteristics of the Twin-Set Hell Gate Boilers".

BOILERS FOR HELL GATE



Two 1,000,000 lb.-per-hr. 900 psi, 950 F B&W Open Pass Boilers of this design are being installed at Hell Gate Station. Each boiler is served by four B&W Type E Pulverizers. Numbers on drawing refer to captions on opposite page.

8 Looking up at 72-inch upper drum shortly after it was hoisted into place. Tube holes are for tubes of the front wall, division wall between the furnace sections and the open-pass, and baffle wall between the open-pass and the gas pass containing the superheater and the economizer.

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
85 LIBERTY STREET . NEW YORK 6, N.Y.

watch

THE CONTINUOUS ASH DISCHARGE AND YOU'LL SEE

THE LINK-GRATE ADDS UP TO THESE 10 ADVANTAGES

- Permits use of low-cost fuel
- Effectively handles all types of loads
- Assures accurate control of air flow
- Fuel bed flow is unrestricted
- Prevents formation of objectionable clinkers
- Ash discharge is continuous
- Provides high reserve capacity
- Keeps operating costs low
- Simplifies control
- Keeps installation cost low

Thorough combustion. No troublesome clinkers. No periodic dumping of ashes. Operating costs are held down. All these advantages because the Link-Grate keeps the fuel bed porous and lets low pressure air flow through the grates.

Westinghouse

PLANTS IN 25 CITIES . . OFFICES EVERYWHERE

LINK-GRATE STOKERS

WHY GIVE MORE STEAM PER POUND OF COAL

There is little unburned fuel in the ash discharge of a Westinghouse Link-Grate Stoker. Combustion is thorough.

Link-Grate motion maintains a regular combustion rate by continuously processing the fuel bed to keep it porous. Agitation at the rear of the stoker promotes a uniform flow of coal over the underfeed section and keeps the burning lanes open.

Grates first move up to break open the fuel bed and let low pressure air flow through the grates. The downward movement of the grates crumbles and conveys the burning fuel.

Positive movements of the fuel bed toward the ash discharge eliminates periodic dumping and reduces labor. Clinkers are no problem. Link-Grate motion prevents closed pores in the fuel bed and eliminates the cause of large clinkers.

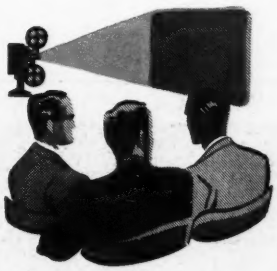
Ability to handle all types of loads is another outstanding characteristic of the Link-Grate Stoker. It can meet suddenly increased steam demands quickly with full combustion efficiency because the fuel bed is always porous.

Before you make another investment in stokers be sure you have complete information about the Link-Grate. If possible, see one in operation. Your nearest Westinghouse office will be glad to arrange an appointment with a present user. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-50462

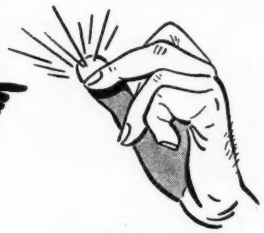
SEE A LINK-GRATE DEMONSTRATION IN YOUR OWN OFFICE

Almost invariably, when a stoker buyer sees a Link-Grate in action he becomes a user. Realizing the difficulty that is often encountered by an individual or group in visiting a stoker installation, Westinghouse has prepared a new 15-minute 16 mm sound movie showing in detail the operation of a Link-Grate Stoker. Prints of this picture are available on loan for your private showing. Just address your request to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.



Link-Grate STOKERS

Just like this



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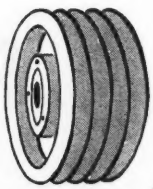
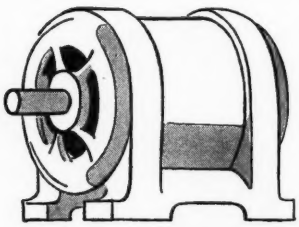


on or off this



Yes, it's a snap to change sheaves now, when you provide Allis-Chalmers' new "Magic-Grip" — *fastest mounting and demounting sheave on the market.* Saves time and money.

SEE WHY THE NEW "MAGIC-GRIP" MOUNTS FAST, PERFORMS SMOOTHLY

1 **Place sheave on shaft.** Slides on smoothly because clearance is provided by expanded bushing. There's *no* hammering — *no* forcing! Complete sheave and bushing unit comes intact—ready for quick, easy mounting.

2 **Align exactly,** using straightedge, (It's easy with this free-sliding sheave.) Then tighten three cap-screws; sheave is locked to shaft, *grips like magic!* No set screws to damage the shaft. Write A-C for Bulletin B6310.

RECONVERTING?

GET THIS NEW FREE KIT!

To help you find out how your present equipment will fit into future production, A-C offers a new free "Reconversion Inventory Kit" — Fact Sheets and Check Lists to speed your appraisal of V-belt drives, electric motors, and centrifugal pumps. Applies to all makes. Call your A-C distributor or district office, or write Dept. 59, ALLIS-CHALMERS MFG., Milwaukee 1, Wisconsin.

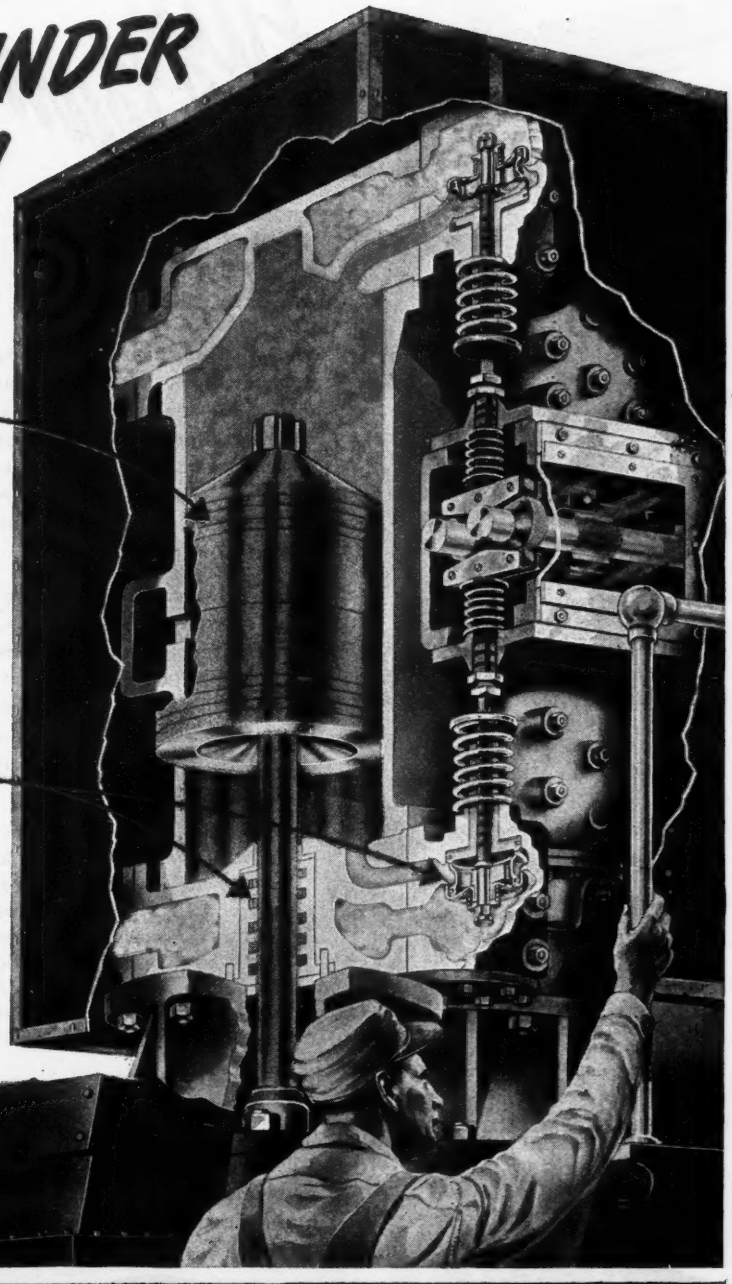
A 1857

Allis-Chalmers Texrope

"MAGIC-GRIP"

SHEAVES

WIN BOTH STEAM CYLINDER BATTLES!



1. PROTECT CYLINDERS AND PISTON RINGS FROM WEAR

Here, on cylinder walls and piston rings, your steam-cylinder oil faces its toughest battle. It must fight both the thinning effect of high temperature and the washing effect of moisture, and form strong, tenacious films that will protect all vital parts from wear. And it must do all this with lowest possible oil feeds. Gargoyle Super Cylinder Oils are famous for strong films that persist on rubbing surfaces to minimize wear. Get them in your engines and be sure of long cylinder and ring life.

2. RESIST DEPOSITS ON VALVE STEMS, PISTON-ROD PACKINGS

Valve stems and piston-rod packings are two other important battle-grounds for steam cylinder oil. Here, despite the high temperatures, oil must resist the formation of hard abrasive carbon deposits that cause steam blow-by and scoring of rods and stems. You can depend on Gargoyle Super Cylinder Oils for this resistance to deposits that means clean valve stems and rod packings. Also, you'll find that these special oils separate readily from condensate to assure clean boiler feed, greater all-around efficiency.

SOCONY-VACUUM OIL CO., INC.
Standard Oil of N. Y. Div. · White Star Div. · Lubrite Div. · Chicago Div. · White Eagle Div. · Wadhams Div. · Magnolia Petroleum Co. · General Petroleum Corp. of Calif.

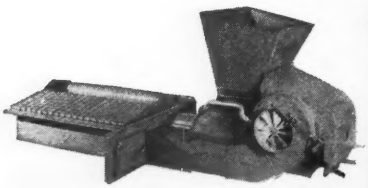
GARGOYLE Lubricants

SOCONY-VACUUM'S 5 Steps to Lower Production Costs:

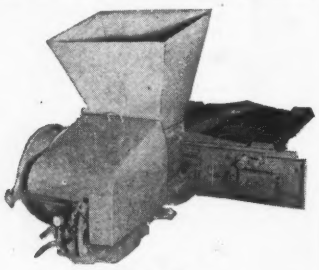
1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured

TUNE IN "INFORMATION PLEASE"—MONDAY EVENINGS, 9:30 E.S.T.—NBC

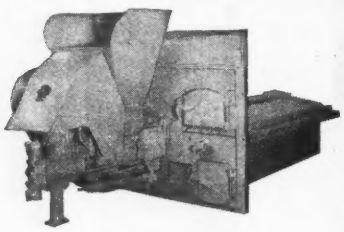
Full Steam AHEAD!



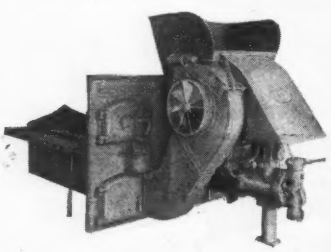
SERIES 40-A
. . . side set stationary or moving grates for Anthracite coal. Capacity 3,300 to 16,700 sq. ft. E.D.R. Steam. Electro-Hydraulic Drive.



SERIES 40-B
. . . center set stationary grates, ash dump for Bituminous coal. Capacity 4,500 to 25,000 sq. ft. E.D.R. steam. Electro-Hydraulic Drive.



SERIES 60-A
. . . with moving grates for Anthracite coal. Capacity 15,000 to 32,000 sq. ft. E.D.R. steam. Electro-Hydraulic or Steam Drive available.



SERIES 60-B
. . . stationary grates for Bituminous coal. Capacity 22,000 to 45,000 sq. ft. E.D.R. steam. Electro-Hydraulic or Steam Drive available.

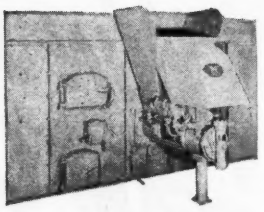
Whatever your power or heating requirements . . . continuous heavy daily schedules or extreme peak loads . . . there is an "F & E" Underfeed Stoker designed to operate your boilers for dependable trouble-free production of steam power.

Check these different "F & E" Stoker models with your heating or power requirements. Remember . . . only in "F & E" Stokers are found this combination of six engineered features that assure you *full* steam ahead to meet your required volume . . .

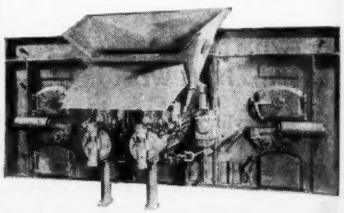
Unit-Type electro-hydraulic drive (steam drive available) . . . Interval timer governor coal feed control . . . Synchronized coal feed and air regulation . . . Moving retort bottom for proper coal distribution . . . Quickly adjustable fuel bed regulator . . . Specially designed high efficiency tuyeres

Your local "F & E" Representative will help you select the "F & E" Underfeed Stoker that will solve your steam production problems for all time . . . Make arrangements to see him today.

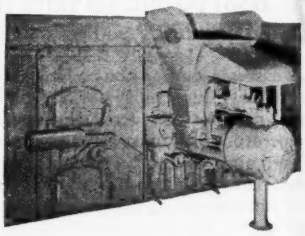
FLYNN & EMRICH CO.
Established 1842
HOLLIDAY & SARATOGA STS., BALTIMORE 2, MD.
Representatives in Principal Cities



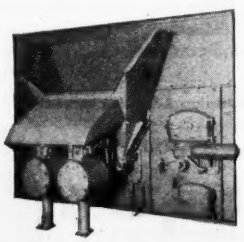
SERIES 70-E
. . . Electro-Hydraulic Drive. Single retort with stationary grates, 300 HP to 550 HP . . . with moving grates, 450 HP to 800 HP. Steam Ram Drive optional.



SERIES 70-E
. . . Electro-Hydraulic Drive. Double retort with stationary grates, 600 HP to 800 HP . . . with moving grates, 800 HP to 1000 HP. Steam Ram Drive optional.

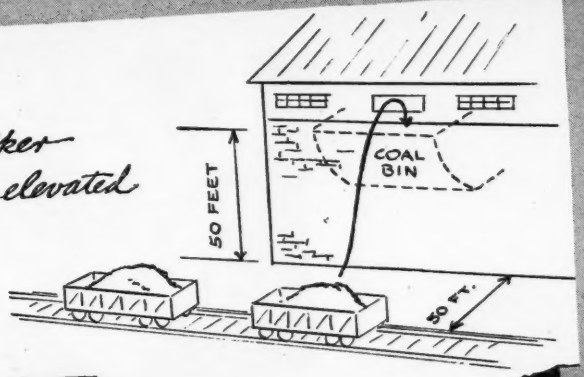


SERIES 70-S
. . . Steam Ram Drive. Single retort with stationary grates, 300 HP to 550 HP . . . with moving grates, 450 HP to 800 HP. Electro-Hydraulic Drive optional.



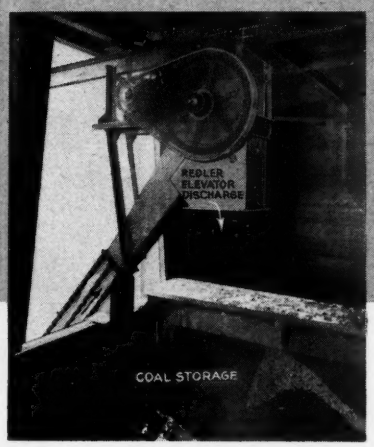
SERIES 70-S
. . . Steam Ram Drive. Double retort with stationary grates, 600 HP to 800 HP . . . with moving grates, 800 HP to 1000 HP. Electro-Hydraulic Drive optional.

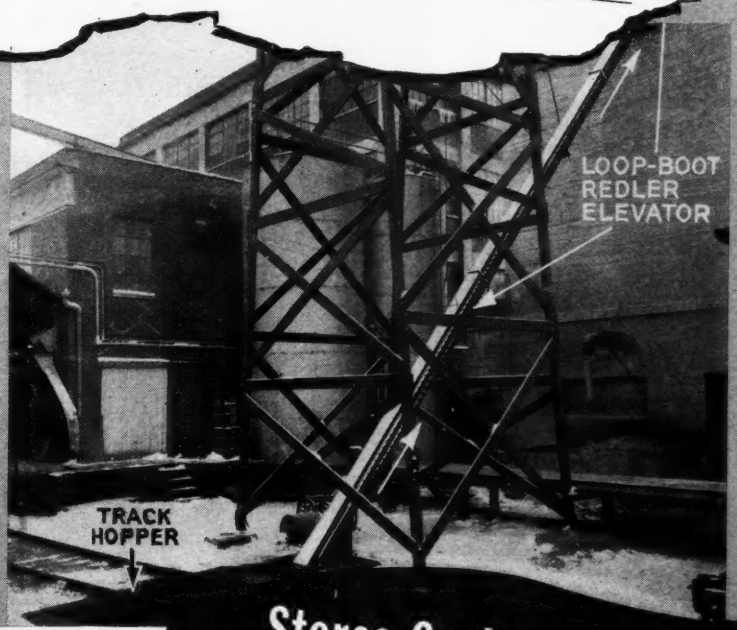
The Problem — to convey and elevate stoker coal from truck hopper to elevated bunker at lowest handling cost per ton



The compact, rigid casing of this 9" REDLER unit, powered by a 7½ h.p. motor, requires little installation space and a minimum of structural support.

This view shows the head end of the REDLER discharging through the bunker port. Note the compact REDLER drive mounted on head section casing.





Stores Coal *Quickly* at Low Cost

The bunker at this power house is 50 feet beyond and 50 feet above the unloading point. S-A Engineers installed a REDLER Loop-Boot Elevator which delivers 30 tons of coal per hour up a 45° incline directly from the ground level track hopper to the bunker. The simplicity of this installation is emphasized by the fact that the alternate bucket elevator and belt conveyor system is eliminated, thereby reducing equipment and operating costs without sacrificing unloading efficiency or volume.

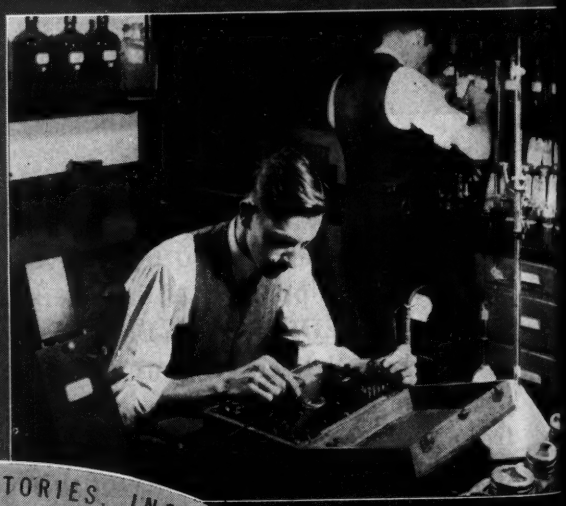
STEPHEN S-A ADAMSON MFG. CO.

15 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Designers and Manufacturers of All Types of

BULK MATERIAL HANDLING EQUIPMENT

A few ppm of



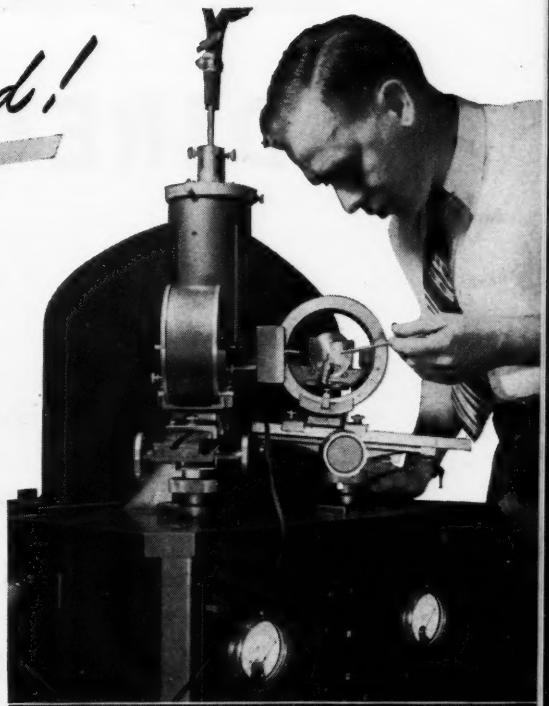
HALL LABORATORIES, INC.

HAGAN
HALL
BUROMIN
CALGON

HAGAN BUILDING, PITTSBURGH, PA.

# of iron rust

made the deaerating heater look bad!



THE deaerating heater in a midwestern food products plant had been guaranteed to deaerate 150,000 pounds of water per hour to 0.03 ml., or less oxygen per liter, by the Winkler test. During a trial period of nearly a year, it apparently failed to meet this guarantee.

Then Hall Laboratories entered the situation. When a careful inspection of the heater failed to show any reason for the trouble, experience in similar situations made the Hall engineer suspect the validity of test results.

Effluent water from the heater was tested for iron oxide—a factor which would interfere with both the Winkler and the Schwartz and Gurney tests for oxygen. As suspected, iron oxide was found.

Installation of a filter in the sampling line kept iron oxide from the sampling flask. Subsequent tests showed that dissolved oxygen was within the guaranteed limit. Quite possibly the heater had actually been meeting its guarantee ever since its installation.

Hall engineers take nothing for granted. Frequently, their wide experience leads them directly to the source of the trouble, but when necessary they check *all* factors involved. Hall Laboratories are equipped for complete analysis of water and of boiler deposits, and for detailed study of boiler tubes.

Write us for full information.

Hall Laboratories, Inc. • Hagan Building • Pittsburgh 30, Pa.

HERE'S WHAT HALL CLIENTS GET:

1. Thorough study of all factors concerning water involved in producing steam.
2. Procedure for the proper treatment of boiler water.
3. Instruction of designated employees in making of essential control tests.
4. Periodic check up by Hall service engineers.
5. Periodic checking of samples by Hall Laboratories.
6. "Trouble shooting" that includes all service necessary as problems arise.

—all of which adds up to
boilers that stay on the line!

HALL SYSTEM *of Boiler Water Conditioning*

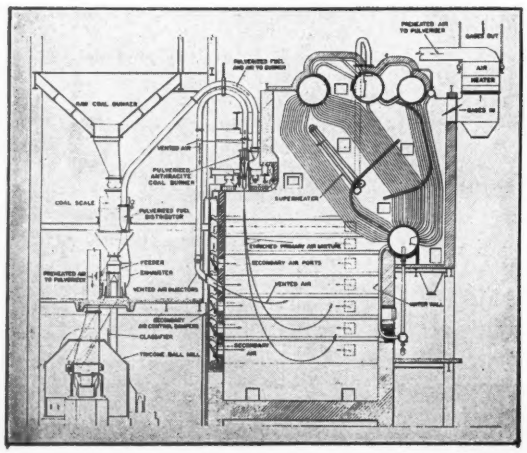
Blazing THE

DIRECT FIRING of

1935

The first Direct Fired Installation of Pulverized Anthracite was made in a large New Jersey paper mill in 1935.

Six more industrial installations have since been made to fire pulverized anthracite with this same FW system in capacities up to 175,000 lb. of steam per hour.



Important savings have been realized from the use of low grade anthracite and a new source of fuel has been made available.

FW FOSTER

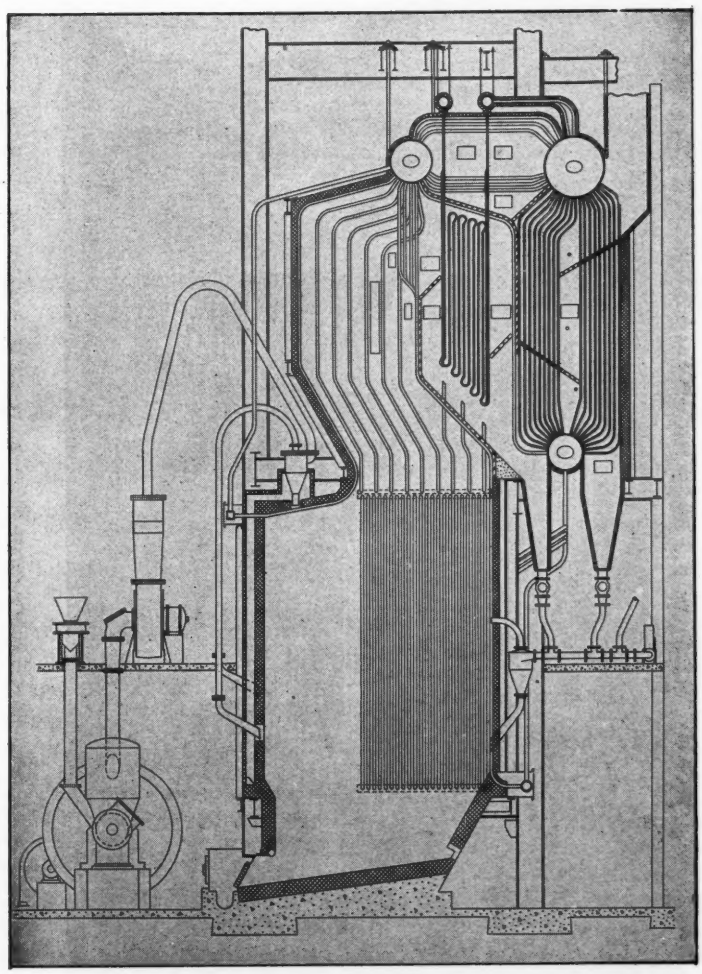
ENGINEERING TRAIL

Pulverized ANTHRACITE

1945

First Central Station Steam Generator for the Direct Firing of Pulverized Anthracite Coal.

Two Units for the Hunlock Creek Plant of the Luzerne County Gas & Electric Co. for 175,000 lb. per hour of steam each.

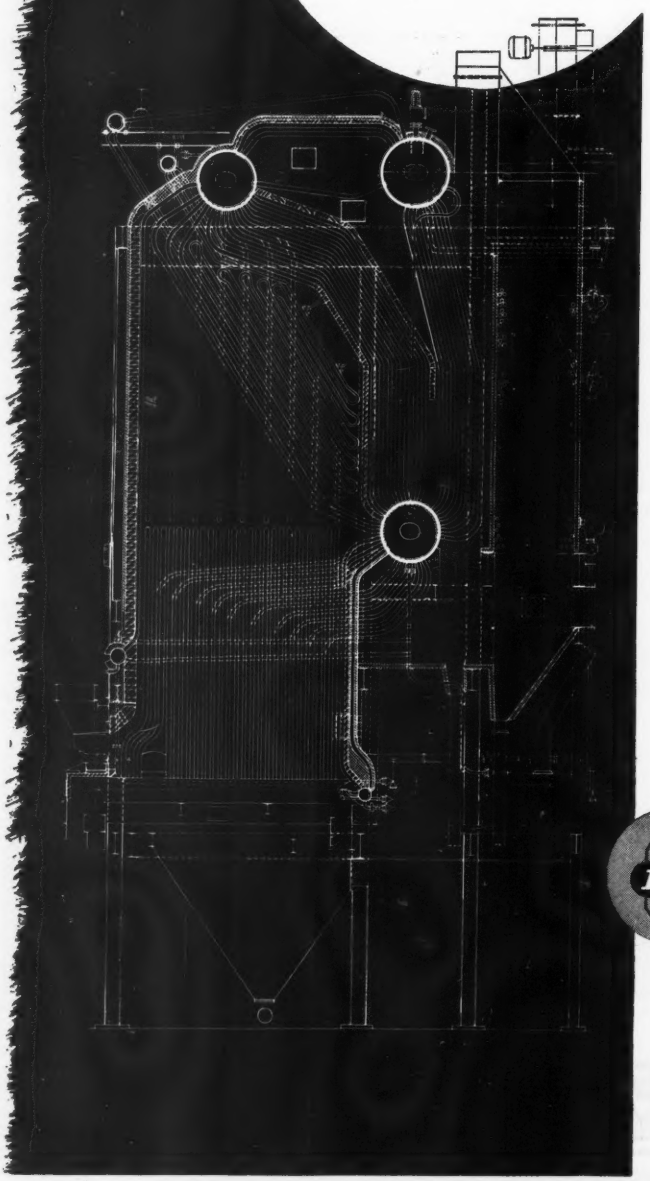


FOSTER WHEELER CORPORATION
165 BROADWAY • NEW YORK 6, N. Y.

WHEELER FW

Edge Moor

standard 3-drum **Bent Tube Boiler**



Typical of all Edge Moor design, the standard 3-drum unit has a record of sustained high operating efficiency for many industries and over periods of many years. This type provides generous water storage with positive circulation at all ratings; it is adaptable to all pressures, capacities, methods of firing and total temperature requirements. Steam drums are equipped with efficient steam dryers or washers as may be required.

The Edge Moor Standard 3-Drum Boiler has its widest application in moderate to large size units where high ratings and continuous service are demanded. With suitable furnace arrangements, it is adaptable to all fuels. EDGE MOOR IRON WORKS, INC., Main Office and Works, Edge Moor, Del. Branch Offices: New York 1, N. Y., Empire State Building; Chicago 2, Ill., One No. La Salle St.

Edge Moor 3-Drum unit equipped with continuous discharge spreader stoker and horizontal bare tube superheater. Capacity, 100,000 lbs. steam per hour at 750 lbs. pressure and 825° F. total steam temperature.

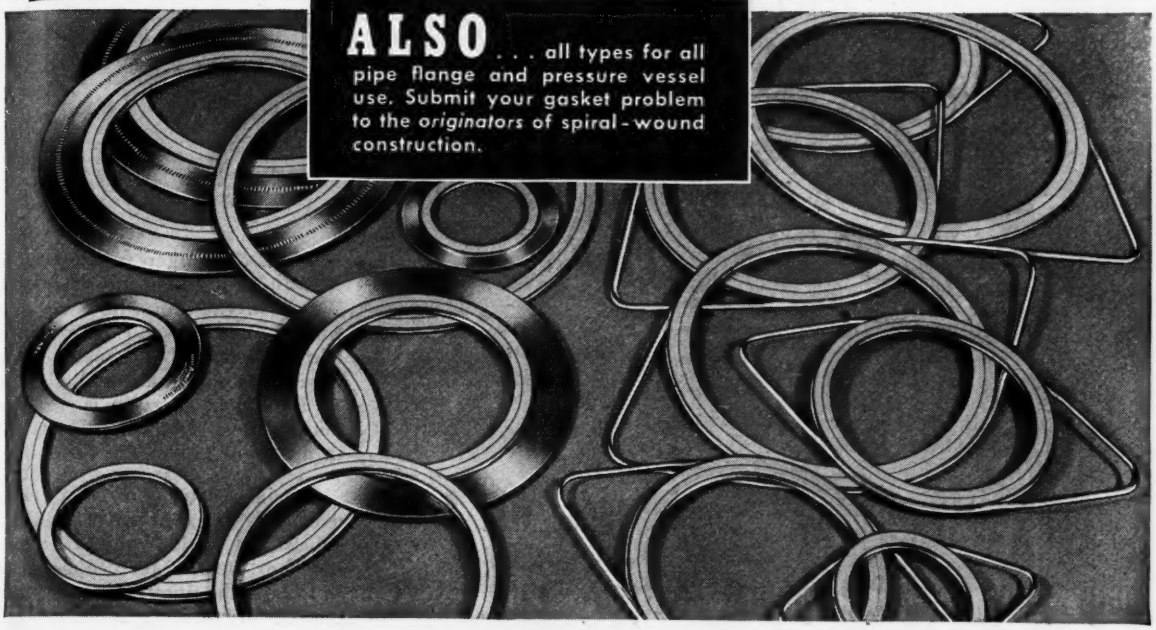
EDGE MOOR

Steam Generating Equipment

C-G —Retaining ring (Compression Gauge) type. Assures proper bonding values.

D —Popular centering guide type incorporates patented Flexitallic construction features.

ALSO . . . all types for all pipe flange and pressure vessel use. Submit your gasket problem to the *originators* of spiral-wound construction.



DESIGNED FOR ANY TEMPERATURE...

ANY WORKING PRESSURE

ARMY E NAVY

- ✓ No Leakage
- ✓ No Bolt Stress Problems
- ✓ No Vibration Worries
- ✓ No Chemical Problems

Given the simple necessities of adequate seating surface and bolting, there is no gasket problem that Flexitallic Spiral-Wound Gaskets can't beat!

Flexitallic is the *original* spiral-wound gasket. Basically its unique metal and asbestos construction is the soundest, most logical approach to difficult sealing problems. Beyond this, however, Flexitallic offers the results of over a third of a century of research and engineering devoted *exclusively* to the continuous development of new and improved spiral-wound types, alloys and designs for exacting modern applications.

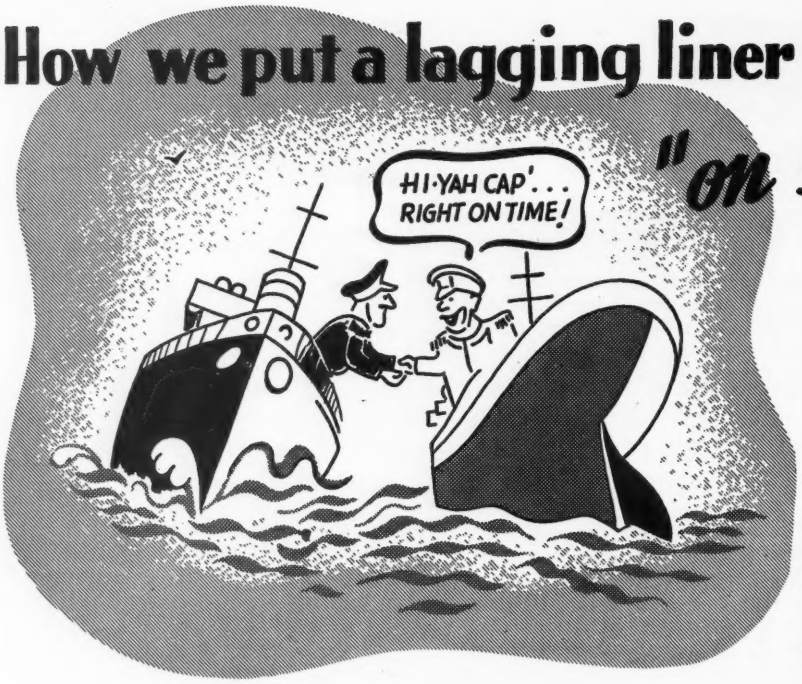
FLEXITALLIC GASKET COMPANY
8th & BAILEY STS., CAMDEN, N. J.

"Flexitallic" GASKETS

REG. U. S. PAT. OFFICE

SAFE, SURE SEALING FOR ALL FLANGED JOINTS

How we put a lagging liner back "on schedule"



Perhaps "ship-shape" condensers will also help you stabilize power output, cut costs

Frequently recurring tube failures in two 10,000 tube condensers in a large new ship, were causing serious delays in sailing schedules.

After considerable discussion, the architects suggested that the shipbuilder, operators and tube manufacturer call on a Conseco engineer to act as referee, and agreed to abide by his decision as to responsibility for the bothersome tube failures.

Following a careful study of the facts in the case, our engineer absolved all concerned of any blame. He pointed out that, on almost any new condenser, some tube failure is to be expected until the "weak sisters" which show up in service are eliminated.

Condenser Service & Engineering Co., Inc., was ordered to weed out these "weak sisters" by its hydro-dynamic shock testing method, by which each tube can be tested without being removed from the unit. After 34 tubes which couldn't pass the test were replaced, these condensers have given no further trouble for more than six years.

For seventeen years, now, we have been servicing condensers and heat exchangers for ships, utilities and industrial power plants. We have the know-how and the time-saving tools to give you a better, faster job. Remember, we operate on a clock-around schedule — *Emergency Service* is our normal business. Don't hesitate to call us any hour of the day or night.

Special feature of a Conseco overhaul is the hydro-dynamic shock test which quickly points out the "weak sister" tubes about to fail. If the number is small they can be plugged; if large, we can replace them fast.

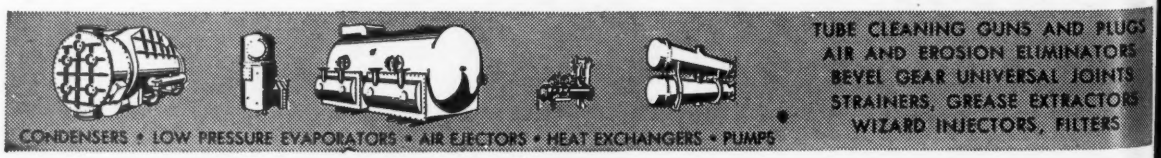
Shock test knocks out "Weak Sisters"

Remember that Conseco Service is nation-wide, day-and-night service. A letter, telegram or phone call will start your job rolling. Estimates furnished for specific work on condensers and heat exchangers.

A highly skilled, specially equipped service organization, ready for immediate action anywhere on the continent, backed by engineering and manufacturing facilities producing over 3,000,000 sq. ft. of heat exchangers annually.

CONDENSER SERVICE & ENGINEERING CO., INC.

71 RIVER ST., HOBOKEN, N. J. Phone HOboken 3-4425 After 6 P. M. or Sundays - HOboken 3-4423



CONDENSERS • LOW PRESSURE EVAPORATORS • AIR EJECTORS • HEAT EXCHANGERS • PUMPS

TUBE CLEANING GUNS AND PLUGS
AIR AND EROSION ELIMINATORS
BEVEL GEAR UNIVERSAL JOINTS
STRAINERS, GREASE EXTRACTORS
WIZARD INJECTORS, FILTERS

How Sarco Serves in
2 LSI ELECTRIC CONTROLS
21 TEMPERATURE REGULATORS FOR PROCESSES
5 87C THERMOTON CONTROLS FOR PLATING
85 STRAINERS UP TO 3"
197 FLOAT-THERMOSTATIC STEAM TRAPS 3/4 to 2"
274 BUCKET STEAM-TRAPS 1/2 to 1 1/4"
27 SH 65 RADIATOR TRAPS
22 RADIATOR VALVES
7 SCRAPER STRAINERS 1 1/4 and 1 1/2"
12 DIAL THERMOMETERS

THE MODERN FACTORY

Here is a typical case with no name mentioned, because it is a defense plant. The industrial company and their contractor decided to standardize on Sarco for all steam traps and temperature control because in their years of experience in connection with many other jobs, there was no other line as broad and versatile and as reliable.

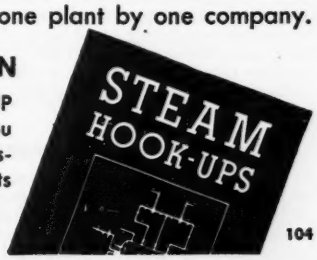
The illustration above shows the extent to which eight different but related Sarco products were used in this one plant, and the wide range of sizes required. Team work in operation was obviously secured.

Other advantages of standardization with Sarco are:

Ease of inspection and cleaning without disturbing the piping. Small number of spare parts required in stores. Ease of obtaining duplicates for additions or extensions, and the knowledge that all parts were made in one plant by one company.

WHEN YOU PLAN

get the Sarco HOOK-UP BOOK which will show you how completely and satisfactorily Sarco products can serve your plant.



104

FOUR STARS ON OUR E PENNANT TESTIFY TO SARCO PERFORMANCE IN THE WAR EFFORT

ARMY E NAVY

SARCO SAVES STEAM

Represented in Principal Cities

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COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*

Anticipate Expansion Program of Power Plant Facilities

New Equipment Will Incorporate Improved Designs and Materials

It has been predicted that the production of electric power by means of steam turbines will be doubled in postwar years in comparison to the prewar average. Modernization of existing units to increase efficiency, as well as new installations, will contribute to this increased output. More efficient use of fuel will be a factor. It is claimed that advances between the first and second world wars resulted in a 300% rise in efficiency, six times the power output of World War I being achieved with only twice the fuel consumption. Similar advances in efficiency have been made through improvement of equipment design and the equally important improvement of materials used.

Boiler and Engine Room Equipment Improved

New techniques, such as the burning of pulverized coal with air at 3000 degrees F. to assure total consumption of fuel, and the use of improved waterwalls, superheaters, economizers, and air heaters have all resulted in higher steam pressures and temperatures per pound of coal. The turbine room has seen progress in the form of new turbines and generators, feed water heaters, evaporators, pumps and condensers that make the most efficient use of this superheated steam. It has been possible to build turbines designed to operate at 1000° F. at pressures up to 2400 lbs. p.s.i. Higher performances are possible with older machines by superposing a new, high-pressure unit upon the original machine. The new turbine takes steam at high pressure and exhausts it into the old turbine at the pressure for which it was built.

Improved Condenser Design

A modern turbine discharges steam at a pressure of only ½ lb. p.s.i. and at a temperature of about 80° F. This low pressure steam (29 inches Hg) cannot be thrown away for two reasons—(1) the condensate must be saved since it is pure boiler feed water, and (2) at such low pressures it cannot be discharged into the air where normal pressure is 14.7 lbs. p.s.i. To discharge a turbine at this pressure would result in loss of some of the total available heat (energy) in the steam. The purpose of the condenser is to maintain a low discharge pressure at the turbine exhaust and collect all water for use again as boiler feed.

Steam at ½ pound absolute pressure has about 30 times the volume the same steam has at atmospheric pressure. The big problem in condenser design is to bring very large volumes of steam into contact with water-cooled tubes without the creation of pressure loss caused by friction of steam flowing around the tube banks. One of the improvements of recent years is the designing of a condenser with tubes expanded at both ends. This reduces leakage of impure circulating water into pure condensate and permits uniform penetration of steam into the tube bank.

Several different arrangements are necessary to obtain the highest efficiency under certain conditions. The largest plants are now using the cross-flow condenser. Where divided water boxes are desired to permit shutting down one side of the condenser while operating the other, the tube bundle is divided by a large steam flow area in the center of the condenser. This arrangement provides maximum entrance area of the steam with minimum friction losses. Where divided water boxes are not essential, a single tube nest is used with a large steam band all around it except at the bottom. Steam lanes are short, and large quantities of condensate do not drip through the steam flow and cause an increase in frictional pressure loss.

Another design used extensively in large units is the direct flow design with circular or bowl-shaped cross section. The steam flows into a number of small steam lanes formed by rows of tubes arranged in radiating straight lines. The entrances provide a larger entrance area than the turbine exhaust area, but not as large as provided in the cross-flow design.

New Developments in Condenser Tube Alloys

These improvements have brought with them more severe operating conditions for condenser tubing. Higher velocities of circulating water required for faster steam condensation result in impingement corrosion which causes premature failure of tubing. With higher steam temperatures, many types of corrosion are accelerated, and ordinary condenser tube alloys will not last as long as expected. Water conditions are also becoming worse because of increasing pollution by chemicals, industrial wastes and sewage.

Selection of the most suitable condenser tubing has become a matter of specifying those alloys which have been designed to stand up under modern conditions. Bridgeport has maintained a consistent program of metallurgical and corrosion research which has resulted in the development of a number of special alloys as well as the improvement of standard condenser tubing. Much has been discovered about the life of various alloys in different types of water. Resistance to dezincification has been increased by the addition of arsenic. Much work has been done on the effect of alloying elements such as iron and aluminum. Many improvements have been made possible by close cooperation between our laboratory and power plant engineers who have tried out test lots of condenser tubing under actual service conditions.

One of the finest condenser tube alloys resulting from research as well as service and field tests is Bridgeport's Duronze IV (special aluminum bronze). This has outlasted other alloys by a wide margin where harbor waters are polluted by sewage and factory wastes, or where salt water is mixed with polluted fresh water in tidal estuaries. Where high temperatures are present and great water velocities cause excessive turbulence resulting in impingement attack cupro nickel is recommended. Cuzinal (aluminum brass) also has excellent resistance to impingement corrosion as well as dezincification.

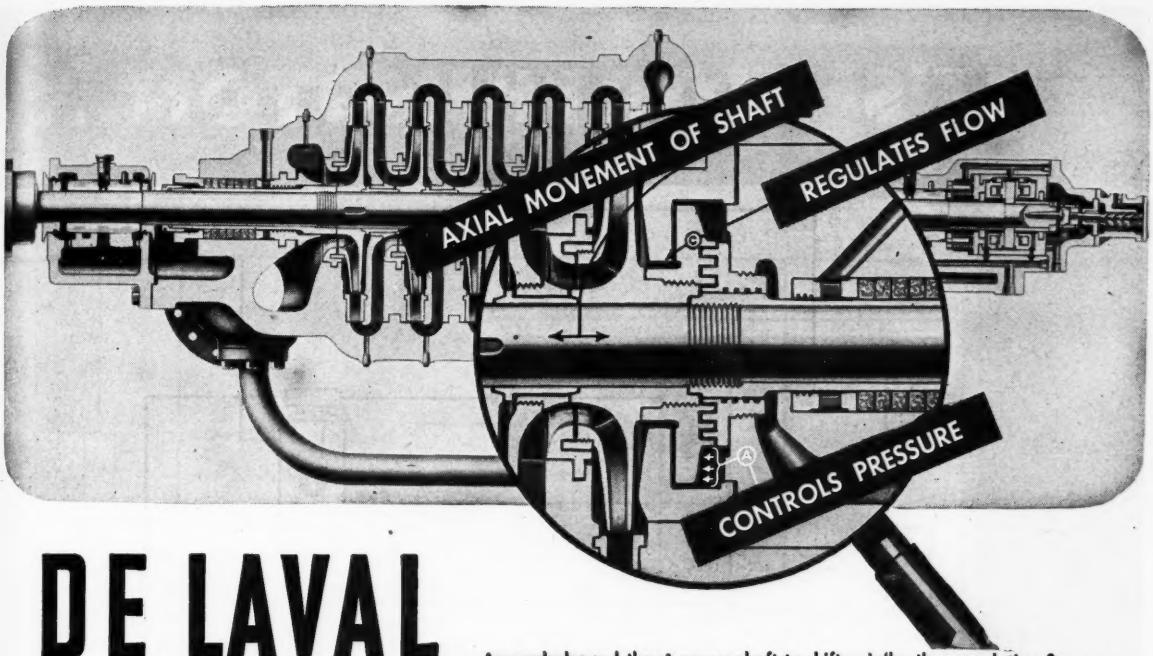
Bridgeport offers a number of corrosion-resistant alloys which are giving a good account of themselves in power plants all over the country. Our Technical Service Department is set up to help select the most suitable alloy for the conditions involved. Bridgeport offices are located in principal cities. Contact the one nearest you, and write for 112-page Condenser Tube Manual full of corrosion research data and information about modern condenser tube alloys.

Note: Bridgeport products are supplied in accordance with existing priority regulations.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN.

ESTABLISHED 1865



DE LAVAL

BALANCING ARRANGEMENT *Automatically* BALANCES ALL THRUST

Any unbalanced thrust causes shaft to shift axially, thus regulating flow through clearance C, thereby controlling pressure against balancing disc A and thus automatically returning the pump to a state of perfect balance. Note that this hydraulic device leaves no unbalanced thrust to be taken up by bearings or other metallic contacts subject to wear.

ELIMINATES SOURCE OF TROUBLE IN HIGH-PRESSURE BOILER FEED PUMPS

The erosive action of high-temperature feed water in a high-pressure boiler-feed pump does not interfere with the operation of the De Laval automatic hydraulic balancing arrangement, since the automatic action of this device is in no way affected by normal wear, as can be seen from the illustration. Its universally trouble-free performance has been demonstrated over a period of 30 years in hundreds of installations, handling feed water up to 350° F. and discharging against pressures up to 1600 psi.

3630

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

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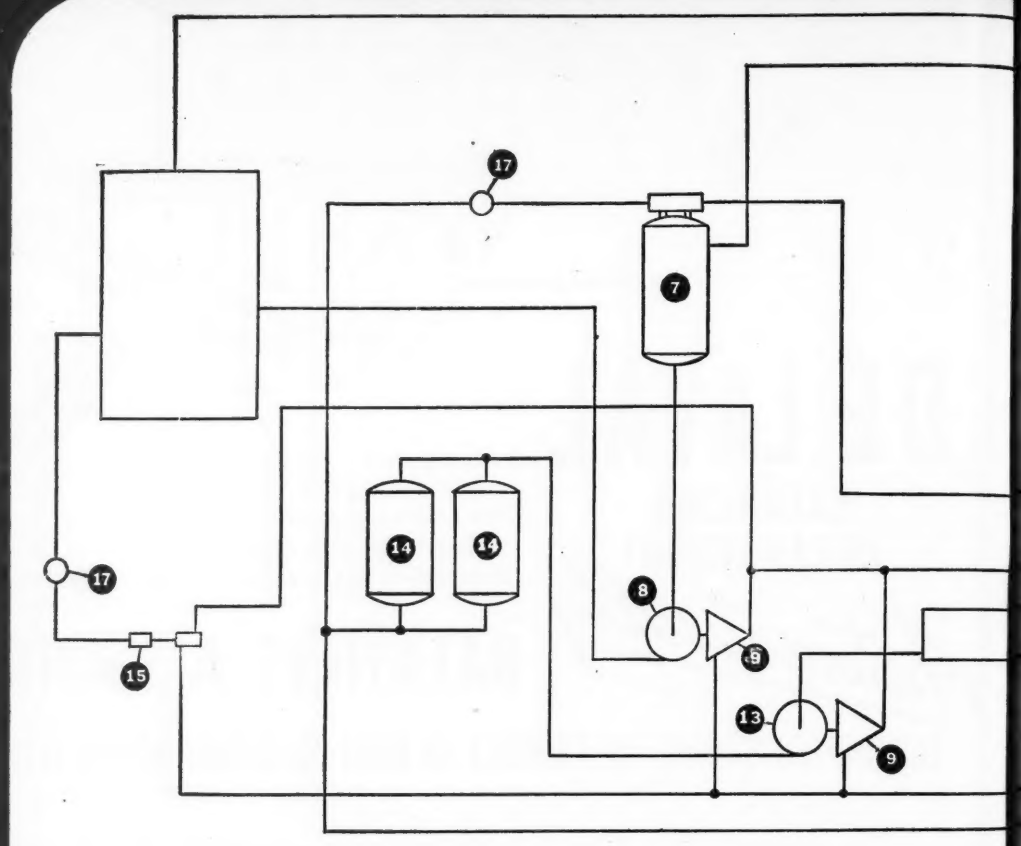
IT'S WORTHINGTON...



1 Extraction Turbine.
2 Generator & Exciter.
3 Switchgear.
4 Condenser.
5 Condensate Pump.
6 Steam Jet Air Ejector.
7 Deaerator.
8 Boiler Feed Pump.
9 Mechanical Drive Turbines.

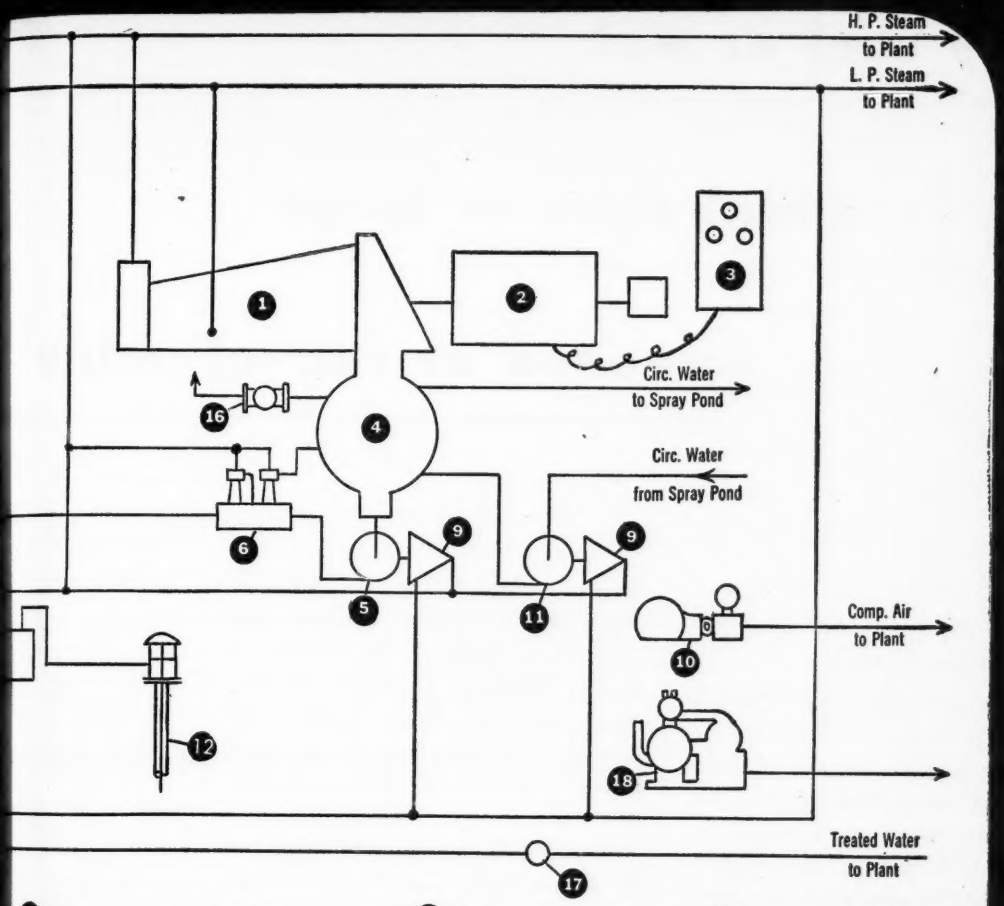
18 Major Items of Equipment for Steam Power Plants Are Products of Worthington

When planning equipment for steam power plants, the name Worthington becomes a logical consideration, because the Worthington line is the most complete . . . backed by engineering staffs that have been responsible for many of the important advancements in the handling of steam and water in power plants.

The flow sheet, representing a typical steam power plant of approximately 7500 kw. capacity, suggests the various items of equipment available under the Worthington trade-mark.

If you have known of Worthington through experience with any one of their products, you will be interested to learn about other types manufactured by the same company. Worthington engineers specializing in equipment for steam power stations are available in all parts of the world. Send the coupon today for information that may serve as the first step in experiencing why *there's more worth in Worthington.*

in Steam Power Plants



10 Compressor with Synchronous Motor.
11 Circulating Water Pump.
12 Deep Well Pump
13 General Service Pump.
14 Ion Exchange Softeners.
15 Fuel Oil Pumps.
16 Atmospheric Relief Valve.
17 Meters.
18 Air Conditioning and Refrigeration Equipment.

WORTHINGTON

FIRST IN STEAM POWER

J5-4

WORTHINGTON PUMP & MACHINERY CORPORATION
Harrison, N. J.

Please send me, without obligation, literature on items checked below.

1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17 18

NAME .....

COMPANY .....

ADDRESS .....

☐ *Check here to have a Worthington representative call.*

Dry coal or wet

small sizes or large

screened or run-of-mine

. . . it is all the same, with the Hagan Differential Master method of Automatic Combustion Control.

Many automatic combustion control systems for pulverized fuel fired boilers use the coal feeder as a coal flow meter. Since the dependability of the fuel feed apparatus as a meter is affected by variations in coal size and moisture content, undesired variations in excess air occur in the boiler furnace.

Previous attempts by others to eliminate these undesirable variations involved the use of correcting mechanisms which had to be limited in speed of operation or extent of correction in order to even approach stable control. By the use of a unique arrangement of standard Hagan apparatus, variations in excess air from this cause are eliminated *without limiting the range of control or reducing speed of operation.*

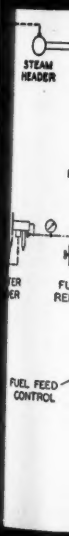
The method employed is simple. A Hagan Master Sender, sensitive to steam header pressure, controls heat input in accordance with demand. A Hagan Differential Master Sender, measuring steam flow, regulates air flow. The rate of fuel feed is changed instantly by the Master steam pressure regulator to compensate for any variation in feeder characteristics, *but air is not changed unless there is an actual change in boiler load.*

With this system of combustion control compensation for erratic coal feed is instant and accurate—by controlling directly and accurately there is no necessity for approximate adjustments, to be corrected later by a lagging corrector.

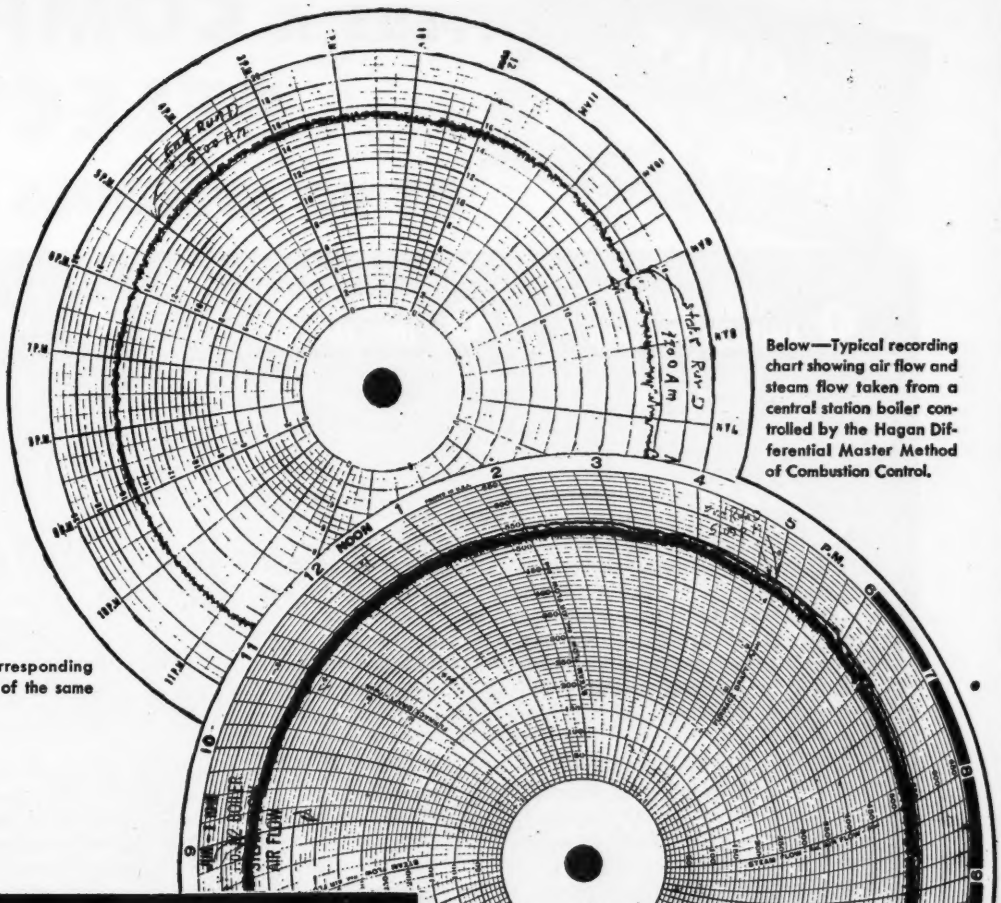
The ability to achieve such results stems from the inherent speed, sensitivity and stability of Hagan Control apparatus.

Write for full information.

HAGAN CORPORATION, Hagan Building, Pittsburgh 30, Pa.

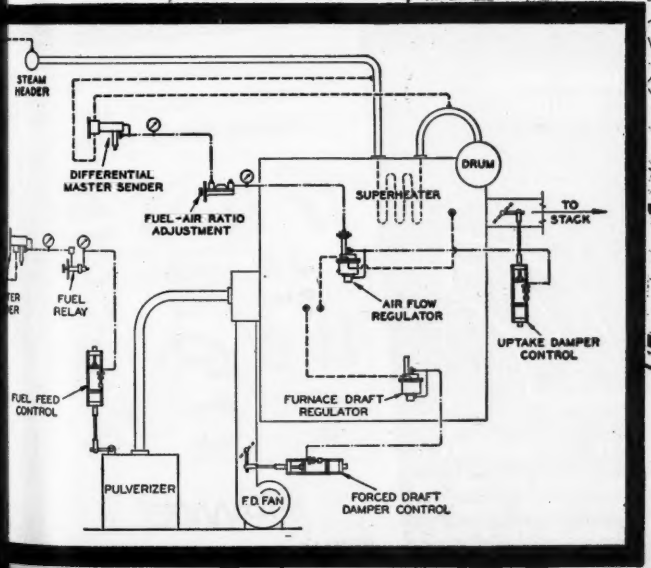


HAGA
HALL
BUROM
CALGO



Below—Typical recording chart showing air flow and steam flow taken from a central station boiler controlled by the Hagan Differential Master Method of Combustion Control.

Above — Corresponding CO_2 Record of the same day.



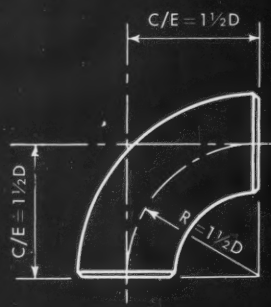
Basic arrangement of the Hagan Differential Master Control system applied to pulverized coal-fired boiler.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

ONLY MIDWEST OFFERS A COMPLETE SELECTION OF 90° WELDING ELBOWS

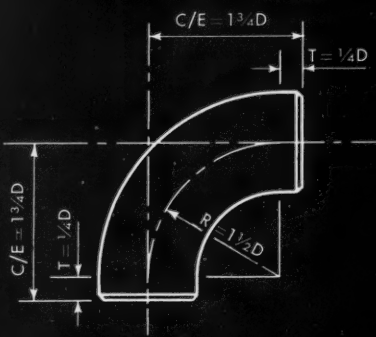
1 LONG RADIUS AMERICAN STANDARD



SIZES: 3/4" TO 12", INCLUSIVE

All dimensions conform to the American Standard for Steel Butt-Welding Fittings ASA B16.9. Unless order specifies otherwise, these "ASA Elbows" will be furnished.

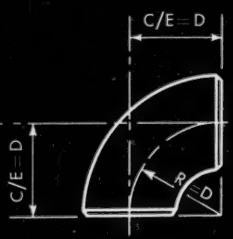
2 LONG RADIUS LONG TANGENT



SIZES: 2" TO 20", INCLUSIVE

Same radius as "ASA Elbows" but with long integral tangent on each end—an exclusive Midwest feature that saves time and pipe, and sometimes eliminates an extra weld.

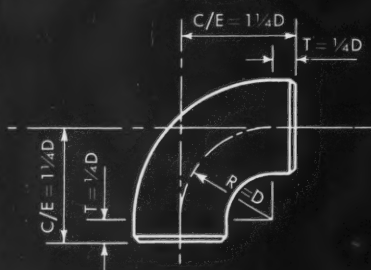
3 SHORT RADIUS



SIZES: 1" TO 12", INCLUSIVE

Where space limitations prevent the use of "ASA Elbows" or Midwest "Long Tangent" Elbows shown at left, these short turn elbows without tangents are recommended.

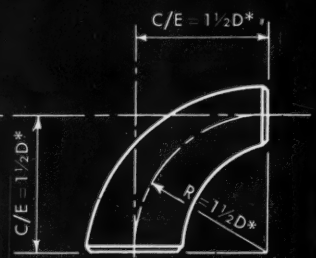
4 SHORT RADIUS LONG TANGENT



SIZES: 14" TO 24", INCLUSIVE

These OD sizes are short radius but have the exclusive Midwest long tangents that save pipe and make it possible to line up the fitting and pipe more quickly and accurately.

5 LONG RADIUS REDUCING



SIZES: 2" TO 12"*, INCLUSIVE

Only Midwest makes the reducing welding elbow which takes the place of a straight elbow and a reducer. It eliminates one weld, cuts installation cost, and reduces pressure drop.

SYMBOLS:

C/E = Center-to-End Dimension
D = Normal Pipe Size
R = Radius
T = Length of Tangent
*D = Dimension is Larger Pipe Size

MIDWEST WELDING FITTINGS IMPROVE DESIGN AND REDUCE PIPING COSTS

MIDWEST

PIPING & SUPPLY CO., Inc.

Main Office: 1450 South Second St. St Louis 4, Mo.

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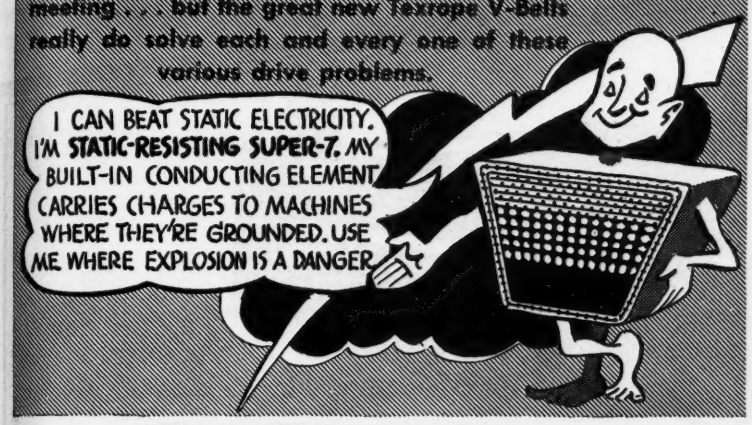
TALL TALES ...but TRUE!

Their exploits may sound like a "Liars Club" meeting . . . but the great new Texrope V-Belts really do solve each and every one of these various drive problems.


I CAN BEAT STATIC ELECTRICITY. I'M STATIC-RESISTING SUPER-7. MY BUILT-IN CONDUCTING ELEMENT CARRIES CHARGES TO MACHINES WHERE THEY'RE GROUNDED. USE ME WHERE EXPLOSION IS A DANGER

Texrope V-belts are available nation-wide through Allis-Chalmers Dealers and Sales Offices. It pays to make Allis-Chalmers your V-belt drive headquarters.

ALLIS-CHALMERS

Texrope Super-7 V-Belts result from the cooperative research of two great companies—Allis-Chalmers and B. F. Goodrich—and are sold exclusively by A-C.

A 1960

BULLETIN!

SPEED RECONVERSION WITH HELP OF NEW FREE A-C KIT!

Guide to "How to Take Reconversion Inventory" of Drives, Motors, Pumps

Help in the big job of reconverting for peacetime production is now offered to plants everywhere by Allis-Chalmers Mfg. Co., its district offices and distributors. To all who request it, we're sending the new "Reconversion Inventory Kit", planned to speed the task of determining the condition of your existing equipment — V-belt drives, motors, and centrifugal pumps — which will be used in reconverted production.

SUGGESTS PROCEDURE, STATES STANDARDS

Used by foremen, maintenance men, and engineers, the Kit is a real time-saver . . . leads efficiently to probable trouble spots, helps clear them up. Gives bearing tolerances, resistance formulae, etc., in compact, easily-used form. Check List appraisal charts help determine present and future condition of units inventoried.

HOW TO GET YOUR KIT

For your free Reconversion Inventory Kit, call your nearest Allis-Chalmers distributor or district office, or write Dept. 81, ALLIS-CHALMERS MFG. CO., Milwaukee 1, Wis.

ALLIS-CHALMERS MFG. CO.
Dept. 81, Milwaukee 1, Wis.

Please send Reconversion Inventory Kit free of charge to:

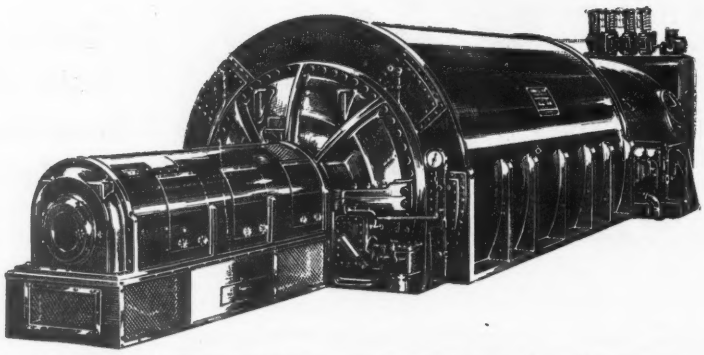
Company.....

Address.....

.....

Attn. of Mr.....

Today's Production Whirlwind calls



New TYCOL RIO TURBINE OILS...

Positive Protection for Your Turbines

Trouble-free, long-life turbine operation depends on the selection of a lubricant of known purity . . . service endurance . . . and high rust and oxidation inhibiting qualities.

Tycol's new RIO Turbine Oils provide that kind of lubrication. Repeated tests, in actual turbine units, showed original viscosity and acidity unchanged. Also, no time-wasting shut-down to clean out the oil reservoir was necessary. A little make-up oil and water removal was practically the only lubrication service demanded.

There are many other time- and money-saving advantages available to every turbine operator through these new Tycol RIO oils . . . one or more are certain to help you. Call in a Tide Water Associated engineer today. Ask him to explain the full benefits of Tycol RIO oils.

TYCOL

TYCOL INDUSTRIAL

ENGINEERED FOR EVERY

for TYCOL
ENGINEERED LUBRICATION

Now more than ever before it is essential to use the best lubricants that can be obtained — for maximum production . . . top efficiency . . . lowest operating cost. That's why more and more operators are turning to Tycol scientifically engineered oils and greases.

Whatever your lubricating need — for mine car or tipple, textile loom or spindle, stationary Diesel or locomotive, steam engine or turbine . . . for extreme pressure, high or low temperature, heavy duty, high speed, or any other service condition — there's a Tycol oil or grease exactly suited to your specific need.

In developing this comprehensive line, Tycol subjects each individual oil and grease to rigid tests during manufacture. This control assures the required lubrication characteristics for maximum performance of that particular product.

Let us prove Tycol Engineered Lubrication efficiency to you . . . show you the extra value in every measure of Tycol oil and grease. Write your nearest Tide Water Associated office for the facts.

***SPECIFIC GRAVITY.** Clear, concise descriptions of the basic tests used to determine important lubrication properties — Carbon Residue, Pour Points, Specific Gravity and others — are given in Tide Water Associated "Lubricania". For your FREE copy write: Tide Water Associated Oil Company, 17 Battery Place, New York 4, N. Y.

UBRICANTS
RVICE NEED

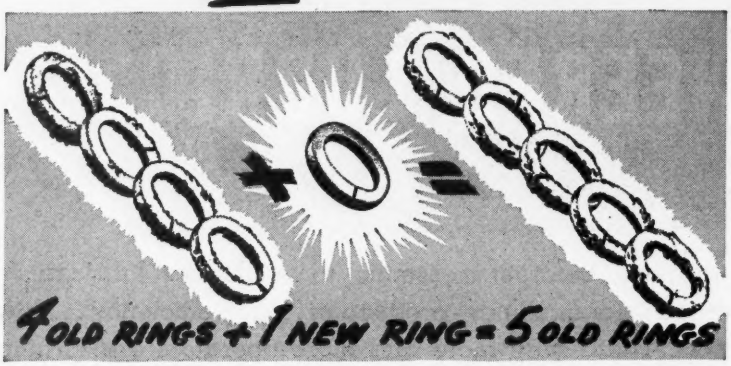
TIDE WATER ASSOCIATED OIL COMPANY

17 BATTERY PLACE · NEW YORK 4, N. Y.

PRINCIPAL OFFICES

To get the most out of a repacking job...

1. REPLACE *all* OLD PACKING



Adding a new ring or two to the old packing in a stuffing box is like adding a quart of new oil to the old, worn-out oil in your car's crankcase. It doesn't do much good. To get a packing job that will *last*—and give proper protection against scoring, (1) remove all old rings, (2) clean out the stuffing box and (3) replace with all new packing. Finally, make sure each ring is properly seated before installing the next one.

2. CUT RINGS FROM J-M KEARSARGE ROD PACKING—

NO NEED TO WORRY about too-frequent repacking when you use Kearsarge! For here is one rod packing that won't *wear* out or *dry* out in a hurry.

Designed for use against high pressure steam, Kearsarge retains its original pliability and resiliency even under continuous high temperature and high pressure service. The reason is found in its unique construction—an accordion-folded center block of asbestos cloth which forms a natural "reservoir" for the preserving lubricant and keeps the packing pliable. Additional resiliency is provided by a red rubber expansion back in the center block. Around this is a double wrapping of asbestos cloth to assure resistance to wear.

Kearsarge is one of many Johns-Manville specialized packings which are minimizing shutdowns and helping speed production in thousands of plants today. If you have a packing problem, write Johns-Manville, 22 East 40th Street, New York 16, New York.

Johns-Manville

PACKINGS & GASKETS

THERE'S A DISTRIBUTOR NEAR YOU

GARLOCK LATTICE-BRAID PACKING Lasts Longer!

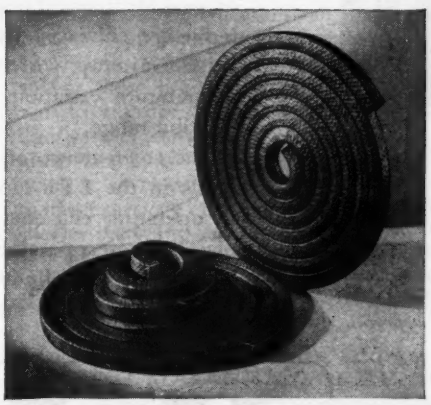
BECAUSE ALL STRANDS ARE STRONGLY LATTICE-LINKED TOGETHER!

PATENTED

The unique structural design of Garlock LATTICE-BRAID holds the strands together even when the packing is worn far beyond the serviceable limits of wear of ordinary braided packings.

This same "lattice" braiding provides unusual flexibility and semi-automatic pressure action.

Garlock LATTICE-BRAID packing is furnished in several styles for various types of service. Write for illustrated descriptive folder.



Garlock 731 Lattice-Braid Coil

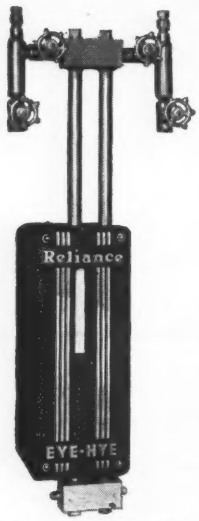
GARLOCK

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.

In Canada: The Garlock Packing Company of Canada Limited, Montreal, Que.

The *Simplicity* of EYE-HYE is the secret of its Dependable Accuracy

The All-Hydrostatic Remote-Reading Water Level Indicator



• *The more than 5000 in use prove the reliability of EYE-HYE's hydrostatic U-tube design. All leading power authorities have given EYE-HYE their approval.*

EYE-HYE works on a basic law of physics that all engineers understand — the hydrostatic U-tube. Simply a glass of water and a few ounces of Vizzene* in a manometer of sturdy design, EYE-HYE gives you the dependable accurate indication you demand for safe operation of your boilers.

There are no mechanically or electrically operated parts to wear, stick or get out of adjustment. Hydrostatic operation throughout means freedom from worry as to calibration or need for frequent maintenance. Accuracy is further enhanced by the Reliance patented Unitemp which compensates for temperature variation throughout the indication range.

The convenience of reading your water levels in the EYE-HYE works wonders in operating efficiency. The indicator is placed where operators are bound to see it frequently; the illuminated green indicating fluid provides a mistake-proof reading that duplicates the familiar boiler gage glass. Two flexible tubes form the easily installed connection between EYE-HYE, located on panel board or wall, and the boiler drum. Can be located below or above the boiler or other tank or vessel for which a dependable double check is desirable.

Plan now for the efficiency of remote water level supervision guaranteed by positive hydrostatic action. Write for full information about Reliance EYE-HYE.

*About Vizzene Fluid

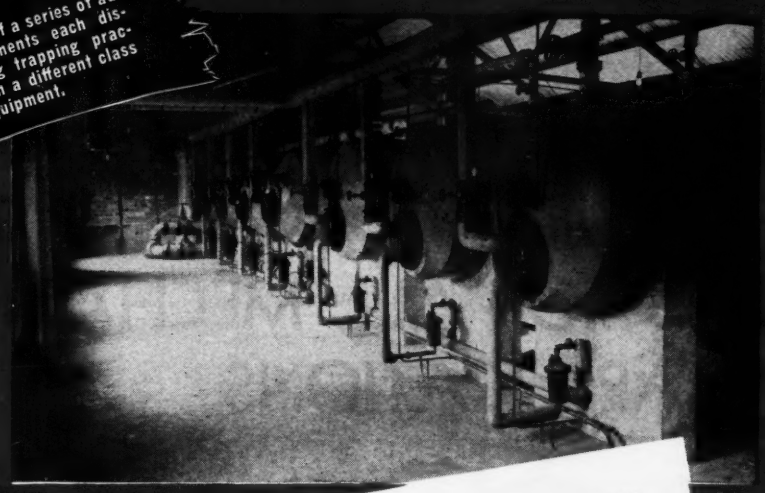
This is an exclusive bromine compound, insoluble in water, developed for use in EYE-HYE after long research — is not available for any other purpose. Vizzene is made in various specific gravities for selective use in best meeting the factors of calibration. It is non-inflammable, has a boiling point above and freezing point below water, is non-injurious in handling. Vizzene is obtainable only from Reliance or authorized sales representatives.

BOILER SAFETY DEVICES since 1884

Reliance

THE RELIANCE GAUGE COLUMN CO. • 5902 CARNEGIE AVENUE • CLEVELAND 3, OHIO

One of a series of advertisements each discussing trapping practice on a different class of equipment.



HOW TO TRAP

SUBMERGED COILS AND TUBES

. . . for higher temperatures

Trapping Tips* on Submerged Coils

- Use a trap on each unit.
- Install trap close to and below unit being drained.
- Use traps that automatically discharge air along with condensate.
- Use traps that discharge condensate at *steam temperature.*
- For extra fast heating, use traps with extra air handling capacity.
- Use adequate safety factor to handle peak loads.

*The ARMSTRONG STEAM TRAP BOOK contains complete data on trap selection including calculation of condensation and heat transfer rate plus recommended *safety factors.* Ask for a copy.

Packing Company Cuts Cooking Time 57%

Selection of steam traps for efficient drainage of condensate from evaporators, storage and instant water heaters, reboilers, ammonia generators, oil tank heaters, and simple open tank heating coils requires *experience* as well as engineering theory. Factors such as circulation, condition of coils, etc., have such a marked effect on condensation rates that calculations are complex and sometimes useless. Armstrong has unequalled experience required for solving these problems—gained on thousands of installations. That's why Armstrong users get results like these:

Duluth Company cuts cooking time 57% —from 8 down to 3½ hours.

Canadian cannery eliminates need for extra boiler after installing 7 traps.

Plating company increases production, improves quality of work, saves coal.

Chemical company saves $25 per day on fuel.

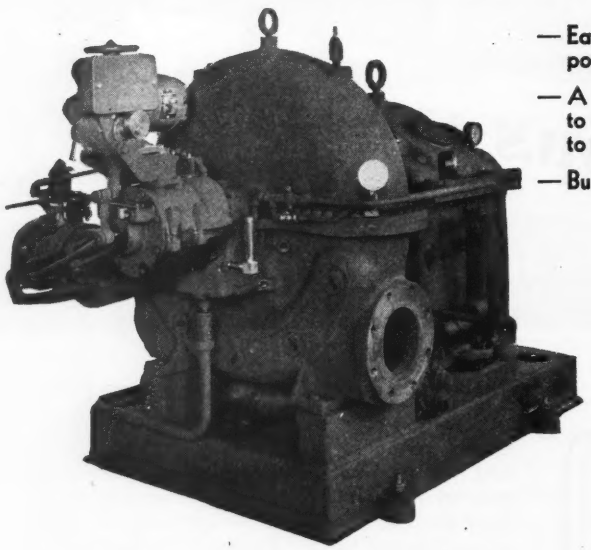
For a survey of your needs, address: ARMSTRONG MACHINE WORKS, 810 Maple St., Three Rivers, Michigan.

ARMSTRONG STEAM TRAPS

Over a Million in Use...For Power...Process...Heating

The TERRY

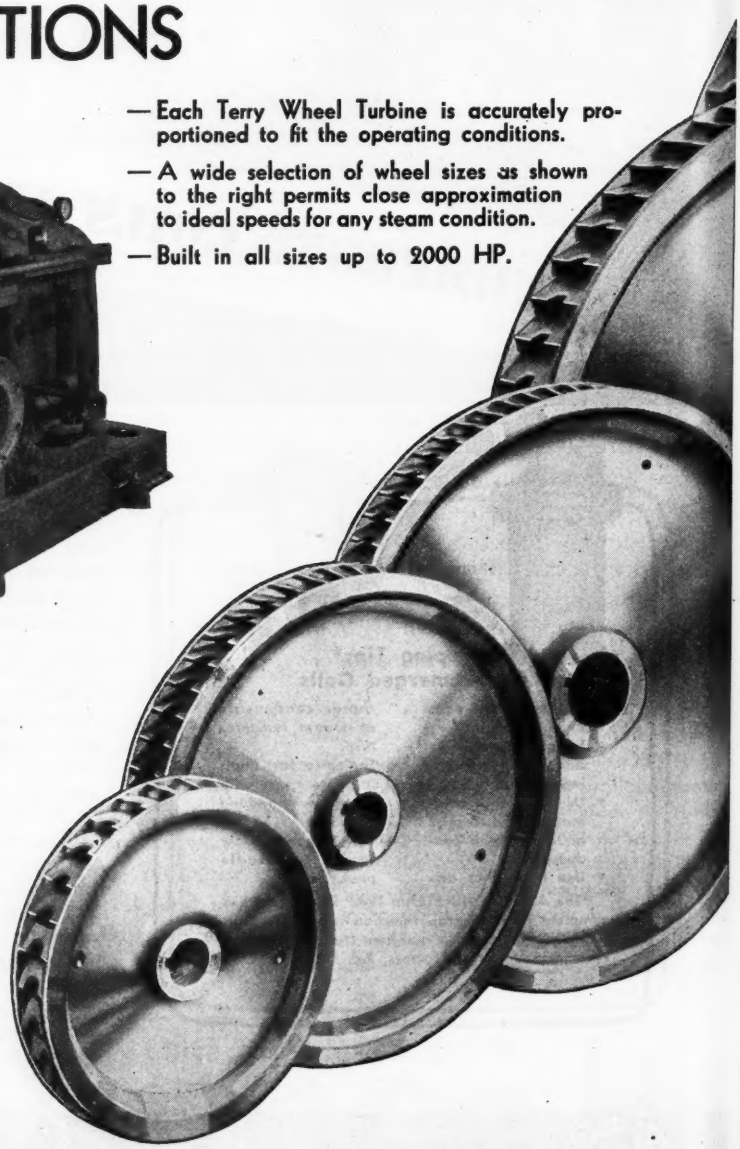
—IS BUILT IN A WIDE RANGE OF SIZES FOR ALL MECHANICAL DRIVE APPLICATIONS



— Each Terry Wheel Turbine is accurately proportioned to fit the operating conditions.

— A wide selection of wheel sizes as shown to the right permits close approximation to ideal speeds for any steam condition.

— Built in all sizes up to 2000 HP.



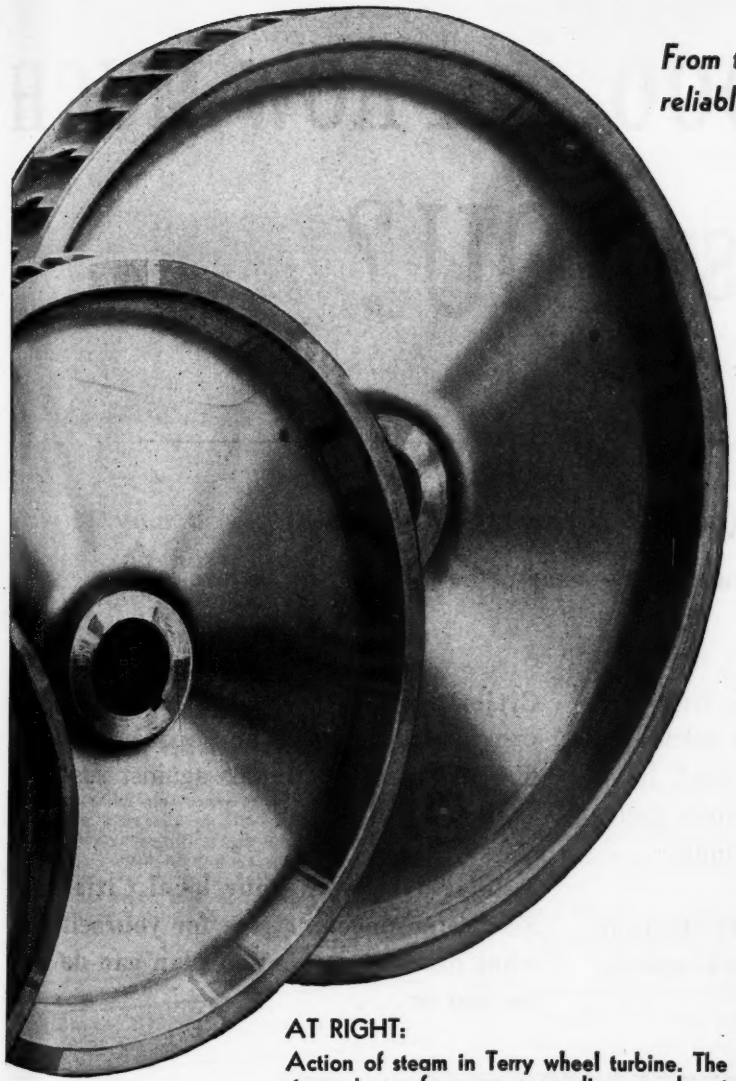
ABOVE:

Typical Terry Solid Wheel Turbo-Gear Unit. Rated 160 HP at 4000 to 1720 RPM with steam conditions of 400 lbs., 750°F.TT, 30 lbs. Used for Blower Drive.

FOR FULL DETAILS ASK FOR BULLETIN S-116

THE TERRY STEAM TURBINE CO.

Wheel Turbine

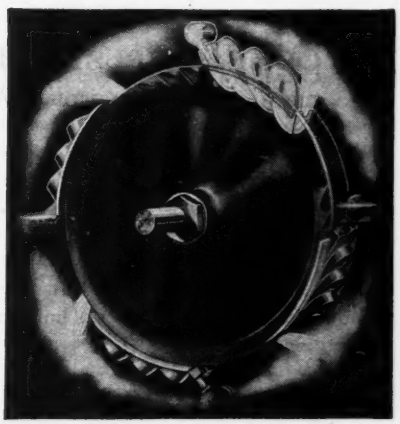


From the smallest to the largest these reliable turbines have—

- ★ Indestructible one piece wheel.
- ★ Large radial and axial clearances.
- ★ Double rim protected blading.
- ★ Individual nozzle control.
- ★ Dependable and durable governor.
- ★ Heavy dust-proof bearing and governor housing.
- ★ Independent overspeed trip with separate valve.
- ★ Sturdy casing design.
- ★ Strong and easily inspected steam strainer.
- ★ Truly accessible construction, which makes inspection of the interior parts a simple matter.

AT RIGHT:

Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.



T-1159

TERRY SQUARE - HARTFORD, CONN.

RUST COSTS INDUSTRY

$100,000,000 ___ HOW MUCH DOES IT COST YOU?

Answer $_____

It would be well worth your while to fill in the answer . . . **because that's exactly how much we believe we can save you.**

Two Cities Service products, Rust Remover and Anti-Corrode, in grades for every specific industrial need, have quickly and effectively helped many companies eliminate this liability.

Cities Service RUST REMOVER clears metals of rust or tarnish. Works quickly —easy to apply.

Cities Service ANTI-CORRODE *prevents* rust, provides an impenetrable film that protects metals against rust or corrosion.

• • •

Talk it over with your local Cities Service engineer . . . see for yourself what his rust prevention plan can do for you or . . .

Cities Service Oil Co.
Room 511, 70 Pine Street, New York 5, New York

Gentlemen: Please send me full information on Cities Service Rust Prevention Plan.

Name .....

Title .....

Company .....

Address .....

City ..... State .....

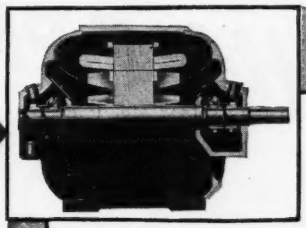
MAIL THIS COUPON TODAY

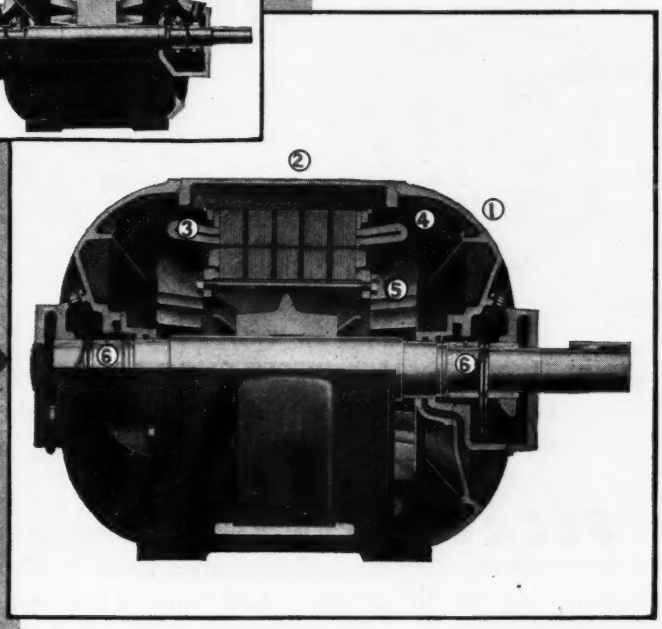
CITIES SERVICE OILS
ONCE-ALWAYS

SAME STRONG POINTS OF CONSTRUCTION

from 1 hp

to 2000 hp





Now all your drives — large and small — can have standard G-E Tri-Clad induction motors with the famous protective features that guard against PHYSICAL DAMAGE, ELECTRICAL BREAKDOWN, OPERATING WEAR AND TEAR.

Tri-Clad, in its wide range of types and sizes (recently increased to 2000 hp), is G.E.'s most widely used (integral-hp) motor. For complete details on ratings, characteristics, and dimensions, write for Bulletin GEA-3580. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

HERE'S TODAY'S WIDER RANGE OF STANDARD SIZES	
Tri-Clad Type K (Low starting current, normal starting torque)	1 hp to 2000 hp at 1800 rpm
Tri-Clad Type KG (High starting torque, low starting current)	5 hp to 200 hp at 1800 rpm
Tri-Clad Type KR (High starting torque, high slip)	Available to 100 hp in speeds required for high-slip flywheel drive (punch press, etc.)

① Cast-iron frame and rigid, cast-iron end shields protect the motor from external blows and accidental abuse.

② Completely enclosed upper portion of frame guards against entry of falling objects and dripping liquids; keeps chips and the like from vital motor parts.

③ Windings of Formex* wire—one of the toughest magnet wires yet developed—resist heat aging, heat shock, and abrasion.

④ End windings are coated with Glyptal* varnish, providing a tough, hard finish that withstands moisture, oil, and abrasion.

⑤ Low-velocity, double-end ventilating system keeps the motor running cool and prolongs insulation life. One-piece, cast-aluminum rotor (used on all but the largest sizes), with integrally cast fans, is practically indestructible.

⑥ Bearings have extra capacity to take heavy shaft loadings from any direction. Lubrication is convenient, its effectiveness well proved.

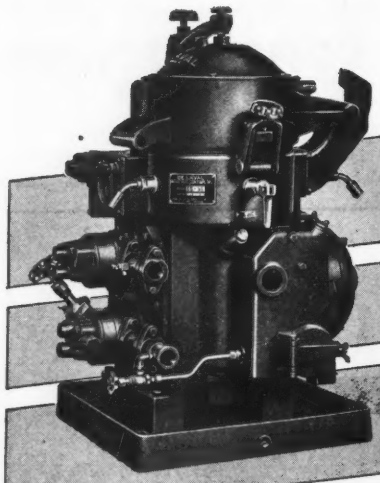
*Trade-mark reg. U. S. Pat. Off.

TRI-CLAD MOTORS

Buy all the BONDS you can — *and keep all you buy*

750-266-8020

GENERAL ELECTRIC



HALF PROTECTION FOR A POWER UNIT IS NOT ENOUGH!

TURBINES AND DIESEL ENGINES **require protection from two different causes of lubrication failure—*water* and *dirt*. Removal of dirt alone merely does half a job. *DE LAVAL* Oil Purifiers provide *complete* protection. Why?**

BECAUSE - De Laval Oil Purifiers continuously remove and discharge water while removing the dirt as well. And water is the real trouble-maker as often as not . . . in turbine lubricating systems, for instance, condensate water in the oil leads to the formation of sludge, and sludge, of course, is well recognized as the real trouble-maker in turbine lubrication systems.

Diesel oils, too, should be kept dry if the formation of emulsions is to be avoided. Today's new, heavy types of Diesel lubricating oil make this phase of De Laval purification by centrifugal force of more than ordinary importance.

Centrifugal force applied in the De Laval bowl gives equally positive protection against dirt . . . keeps the oil clean and in "like-new" condition.

In short, De Laval Oil Purifiers afford turbines and Diesel engines ***full protection*** against the principal causes of lubrication failure, by removing the impurities that contaminate oil in service.

ADVANTAGES OF DE LAVAL LUBRICATING OIL PURIFIERS

Constant high purifying efficiency—without renewal of functional parts

•

Economical to operate

•

Remove both enemies of good lubricating oil performance: water and dirt

•

Provide maximum protection to power units

•

Give long, trouble-free service

•

Lower maintenance costs

•

Maintain oil in condition most nearly identical with that of new oil

•

Self-draining purifier bowl makes for easy cleaning

DE LAVAL

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 19
THE DE LAVAL COMPANY, Limited
MONTREAL PETERBOROUGH WINNIPEG VANCOUVER

LUBRICATING OIL PURIFIERS

JUST RELEASED—Data Book No. 1000

Giving Complete Data On

REPUBLIC PNEUMATIC TRANSMITTERS

Operating On the Force-Balance Principle

For the Measurement and

Control of

FLOW • PRESSURE • LIQUID LEVEL • DENSITY

WRITE FOR YOUR COPY TODAY

Republic Pneumatic Transmitters are devices for converting process variables, such as flow, liquid level, pressure or liquid density, into air pressures which vary proportionally with the process variables.

These air pressures become direct measures of process variables and can be conducted to remote locations by means of tubing. A gage or receiver connected anywhere in this transmission line can be graduated to permit direct reading of the measured variable. This pressure can also be used as the measuring impulse for the actuation of an automatic controller.

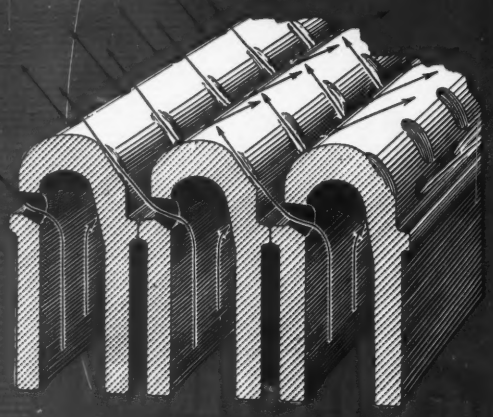
In this manner, measurement readings may be transmitted pneumatically to locations remote from the points of measurement, eliminating the necessity of running lead lines containing corrosive, inflammable, toxic or otherwise dangerous fluids into control rooms. The installation of flow, pressure, and liquid level measuring instruments, is immensely simplified through the elimination of long lead lines, and liquid legs, and the elimination or simplification of liquid seal and purging systems.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

"CROSS FIRING"

GIVES BETTER AIR DISTRIBUTION



The dumping grate bars of the Æ Perfect Spread Stoker are uniquely designed with "staggered" non-clogging ports to provide a steady cross flow of air that uniformly blankets the entire grate area. This assures a rapid and complete mixture of fuel and air, and a uniform burning rate at all times. In addition, the bars are thoroughly air-swept from below for proper cooling.

END BOILER ROOM DRUDGERY

DIRTY, tiresome jobs with hand stoking that make boiler room operations wasteful and distasteful are virtually ended when you install an Æ Perfect Spread Stoker. You'll marvel at the elimination of these inefficiencies and the way steam and operating costs drop.

Fully automatic and simple in operation, this modern, streamlined stoker requires practically no attention. It runs steadily, quietly—regardless of the steam demands—without clogging or jamming. It keeps the boiler room neat and clean and makes grate cleaning and ash removal surprisingly easy.

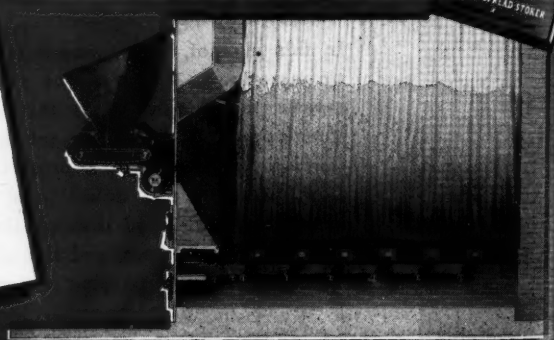
When you consider all these advantages, as well as its ability to burn economically the widest range of solid fuels, you'll see how the Æ Perfect Spread Stoker keeps labor requirements low and makes waste go. You can get all the facts by writing today for the eye-opening Æ bulletin on low cost steam production.

If Your Steam Requirements Call for 175 H. P. up to 200,000 lbs. per hour—

YOU NEED THIS BULLETIN

Write us. 2408 Aramingo Ave., Philadelphia 25, Pa.

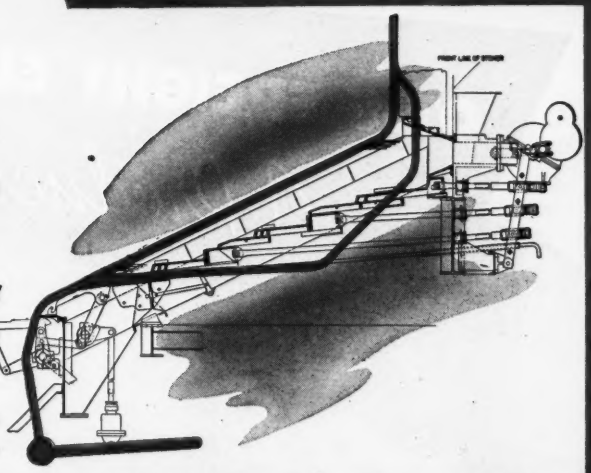
Æ PERFECT SPREAD STOKER



AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PENNSYLVANIA

WILL THIS STOKER AFFECT YOUR FUTURE OPERATIONS?



PERHAPS you've heard about the *improved* Taylor Stoker—a time-tested stoker with outstanding *new* features that you should not overlook when selecting fuel firing equipment for your future power plant operations.

Precision control feed mechanism and provisions for better air flow mean more thorough combustion and minimum stack discharge. The stoker has simplified unit construction throughout with fewer moving, longer wearing parts. Continuous ash discharge and numerous other advantages are additional aids to efficient operation and low cost steam generation.

Examine *all* these features in the Type "R" Taylor Stoker booklet before you make *any* decision. A few minutes invested this way will pay dividends in worthwhile information. Mail your request to us *today.*

TYPE "R" WATER-COOLED TAYLOR STOKER has Important Operating and Maintenance Advantages

The Taylor Stoker is available with integral water tubes connected into the boiler circulation. This feature assures maximum fuel flexibility, higher operating efficiency and low boiler outage.

IF YOUR Steam Requirements Call for 20,000 to 500,000 lbs. per hour—

YOU NEED THIS BOOKLET

Write us. 2408 Aramingo Ave., Philadelphia 25, Pa.

TAYLOR STOKERS

AIR-COOLED & WATER-COOLED

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PENNSYLVANIA

OTIS FREIGHT ELEVATORS

. . . A Production Asset

The efficiency of tomorrow's production will be influenced by the handling capacity of freight elevators.

The smooth dependable performance of OTIS Freight Elevators is an assurance of more tonnage hauled . . . more time saved.

OTIS Freight Elevators can be arranged for dispatching to predetermined floors — to fit exactly the requirements of any cycle of operations.

Ask your OTIS representative about Collective Control for high-speed freight elevators and Double Button Control for moderate-speed freight elevators.

For the finest in vertical transportation tomorrow, call your OTIS representative today.

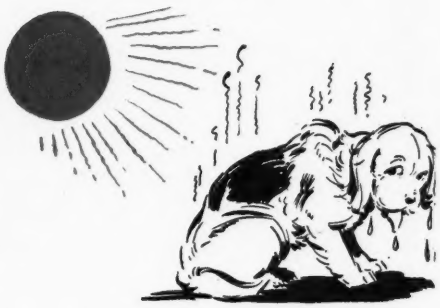
Otis ELEVATOR COMPANY

OFFICES IN ALL PRINCIPAL CITIES

Turbine oil leads a dog's life . . . but Nonpareil can take it

MOISTURE is a problem in some turbines. Usually it's the result of condensation in tanks and oil lines which causes the oil to emulsify, particularly if it has high acidity. Because the additive keeps down acidity—usually below 0.10 mg. KOH/gm.—Nonpareil doesn't emulsify readily and is easily separated from water.

METAL SOAPS cause trouble when acids form in the oil. The acids react with metal parts of the turbine and eventually form deposits. Not so with Nonpareil and its anti-acid-forming additive.



ALL DAYS ARE "DOG DAYS"

in your turbine. Heat plus agitation of the oil in a turbine causes oil oxidation which, in turn, causes turbine deposits. Nonpareil effectively resists oil oxidation. First, because all asphaltene formers have been removed by refining. That cuts down one kind of deposit. But when asphaltene formers are removed, conventional turbine oil usually increases in acidity very rapidly resulting in other deposits and trouble. That's where Nonpareil differs from most turbine oils. A special additive is used to prevent acidity formation. Therefore, deposit-forming elements in Nonpareil are safely eliminated.

TROUBLES with deposits, acidity, and turbine oil maintenance "take off" when Nonpareil "takes over." Let a Standard Oil Lubrication Engineer discuss with you all the advantages that Nonpareil Turbine Oil offers—particularly the savings that can be made on new turbine installations. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, for the Engineer nearest you.

Buy and hold more Victory Bonds

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . .

LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . .

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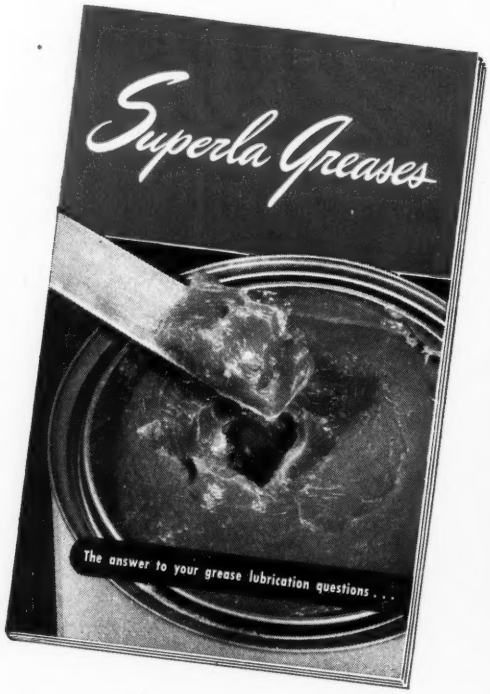
One complete line of greases . . . Superla greases

Can replace many special, premium priced greases on a wide range of applications.

SUPERLA GREASES in your plant will simplify your lubricating problem. This line of greases, in two types—Superla Numbered Greases and Superla "X" Greases—will handle most antifriction bearing lubrication jobs—from low to high speeds and low to high temperatures.

In many instances, Superla Greases have replaced special greases and thus have simplified the job of ordering, stocking, and applying lubricants. This advantage of wide application is the result of combining many grease qualities in one line of high-grade lubricants. You can find out what these qualities are and what they mean in better lubrication by getting the booklet illustrated. In applying these greases to your particular job you can get valuable help from a Standard Oil Lubrication Engineer. You can reach him through the nearest Standard Oil Company office.



Send for a copy of this booklet

It describes the characteristics of the various grades in the Superla Grease line and suggests applications. Simply write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, for your copy.

Buy and hold more Victory Bonds

SUPERLA GREASES

STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE

★ LUBRICATION ENGINEERING

HOW BAILEY CONTROLS INCREASE SAFETY

SAFE BOILER OPERATION

EXPLOSION HAZARDS REDUCED

1. Automatic Readjustment of fuel-air ratio insures proper mixture for safe efficient combustion.

2. Limit stops and accurate draft control protects against loss of ignition at low ratings.

3. Interlocks may be provided to trip out equipment upon failure of related units.

4. Purge interlocks insure safety in lighting-off.

OPERATORS FREE TO ACT

In emergencies control automatically carries on leaving the operating personnel free to concentrate on the cause of the emergency.

SAFE STEAM TEMPERATURE

Prime movers, superheaters, valves and piping are protected against excessive steam temperatures by superheat control.

NORMAL WATER LEVEL

Damage to turbines from water carry-over and to boiler tubes from low water is avoided by effective feed water control.

BOILER FEED PUMPS

Automatic by-pass control protects feed pumps at low rates of flow.

IN YOUR PLANT

There may be applications where Bailey Controls will improve safety, lower fuel and maintenance costs, and enable you to render better power service.

Call on your local Bailey engineer to make recommendations or write for Bulletin 15-C which describes Bailey Controls for Steam Plants. Bailey Meter Company, 1040 Ivanhoe Road, Cleveland 10, Ohio. In Canada—Bailey Meter Company Limited, Montreal.

A-93

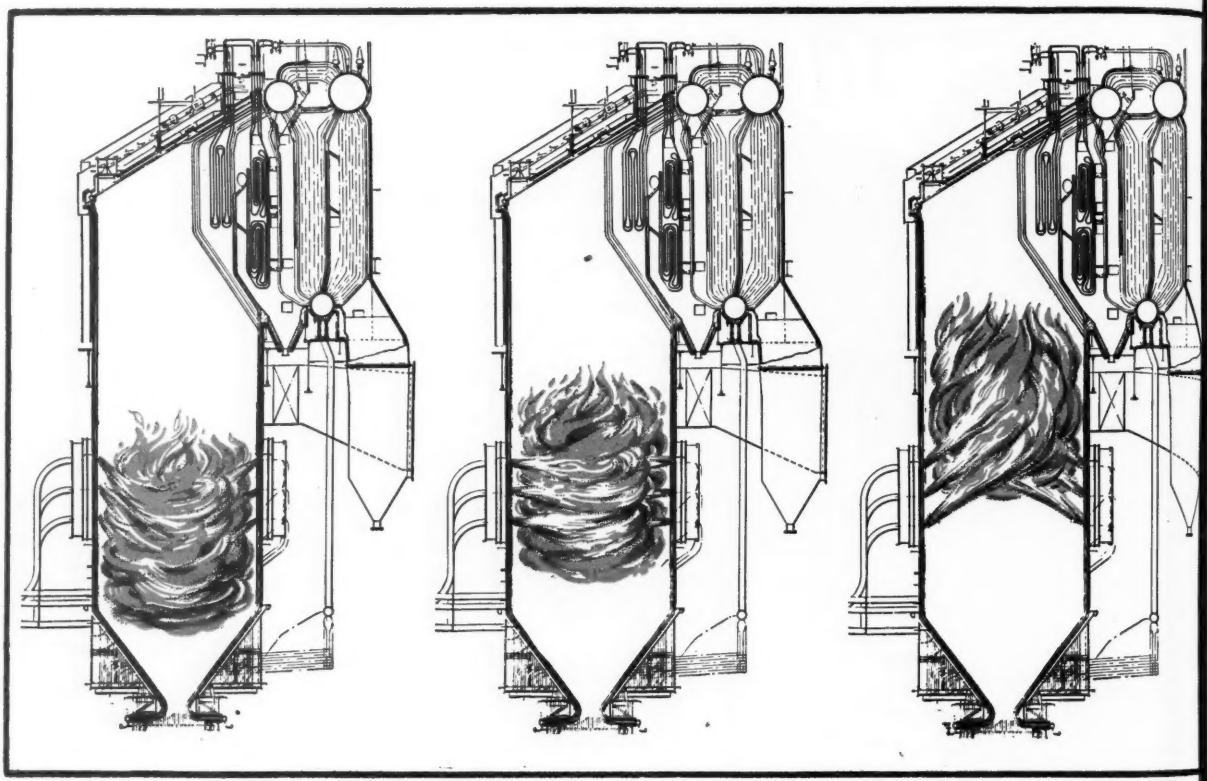
BAILEY METER COMPANY

1040 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

THE ADJUSTABLE



C-E Steam Generating Units with Adjustable Furnaces have an Aggregate capacity of 12,500,000 lb of steam per hr more than 70% of which is now in service.

COMBUSTION

FURNACE

WITH present-day demands for constant superheat temperature over a range of ratings, the problem of both the designer and operator has been a difficult one. Economic considerations have dictated the use of high capacity boilers capable of taking wide load swings, with corresponding variations of gas temperatures entering the superheater, while turbine requirements closely limit the permissible variations in superheat temperature.

In a great many plants a further complication has been introduced by the necessity of using coals of low ash fusion temperature which tend to create serious slagging conditions at the top of the furnace, especially at the higher loads. Although the use of by-pass dampers and desuperheaters have been of considerable aid in meeting the problem of superheat control, they do not provide an answer to the problem of maintaining the desired margin between upper furnace gas temperatures and the fusion temperatures of the ash.

Obviously if some means could be found for varying the amount of heat-absorbing surface in the furnace or otherwise controlling furnace heat absorption, it would be possible to control gas temperatures entering the boiler and thus strike at the root of the problem. In other words, an "adjustable furnace" is needed.

In effect this is just what Combustion Engineering achieves with its "Vertically Adjustable Tangential Burners." The illustrations show how the operator can raise or lower the flame body over a considerable distance to make selective use of more or less furnace heat absorption surface and thereby effect wide range control over the gas temperatures leaving the furnace. Test results in one installation have shown that with the burner nozzles tilted from −24 to +24 degrees, the variation obtainable in gas temperatures at the top of the furnace ranges from 215 F at half load to 165 F at full load.

Thus, C-E Vertically Adjustable Tangential Burners provide two important advantages:

(1) primary, wide range control of superheat temperature

(2) substantial control over slagging conditions

These advantages are obtainable regardless of coal quality or load variations.

Since Vertically Adjustable Burners enable the operator to control furnace heat absorption just as though he were able to increase or decrease the size of the furnace at will, they provide, in effect, an "adjustable furnace." A908

C-E

ENGINEERING

200 MADISON AVENUE • NEW YORK 16, N. Y.

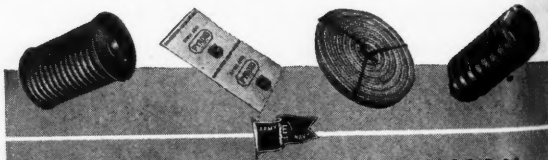
for the long pull

For the long pull . . . whether you're talking about a long pump-stroke, or a long period of time . . . pick R/M packings.

In the oil-fields, where pump-strokes often measure eleven feet in length, specially designed R/M packings are used for pumping everything from mud to natural gas. And they're made for the long pull . . . to stand-up under terrific, high pressures; erosion from sand; corrosion from sulphur compounds; the deteriorating effects of petroleum.

For every industrial use, there are R/M packings, "Made for the long pull" . . . more than 73 different types . . . each in a wide number of sizes . . . in coils, spirals, bulk, sheets, rings, wicks, tubes, gaskets, spools, or flat sheets.

Ask your distributor. Or send for R/M's free 45-page catalog and recommendation chart.



INDUSTRIAL SALES DIVISION

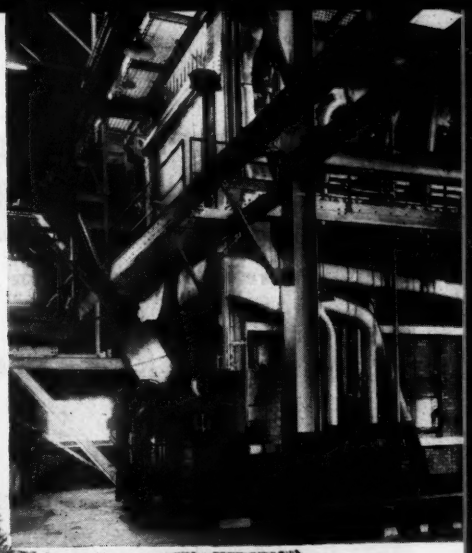
RAYBESTOS-MANHATTAN

INCORPORATED

Manheim, Penna. · Bridgeport, Conn.
North Charleston, S. C. · Passaic, N. J.

It's "Packed with Satisfaction" When You Use R/M

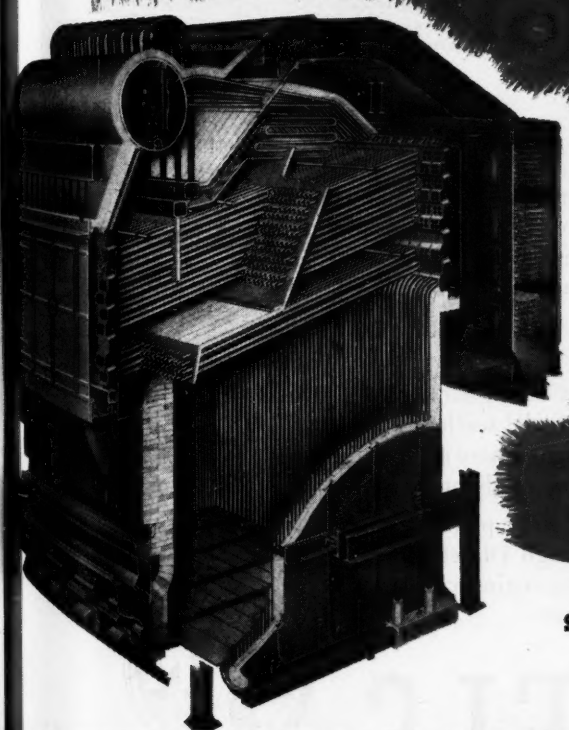
HOW MUCH COAL WILL YOUR BOILER waste this winter?



If it's a Springfield, you can be sure of minimum coal wastage — maximum utilization of the B.T.U. content of every pound of coal. The reasons for lower operating cost with a Springfield unit are found in the same features that will cut your coal consumption during these days of fuel shortages.

Here are just a few of these features:

- Springfield boiler tube surface is arranged to efficiently absorb heat from the combustion gases by using small diameter tubes and by cross flow of gases, which forces gases into contact with the boiler tubes.
- Springfield sectional one-piece baffles, designed and developed for use with this type of boiler, prevent heat losses that occur with leaky baffle construction.
- The single cross drum arrangement used on Springfield boilers with all steam delivered above the normal water level provides dry steaming and prevents heat losses due to water carry-over.
- Springfield furnaces are designed with adequate water cooling to deliver any fuel available, and are backed by Springfield pioneering experience in the development of the first successful water cooled furnace and the first successful center wall furnace.
- Contracts taken for complete steam generating units. Write today!



SPRINGFIELD BOILER CO.
1951 E. Capitol Ave.,
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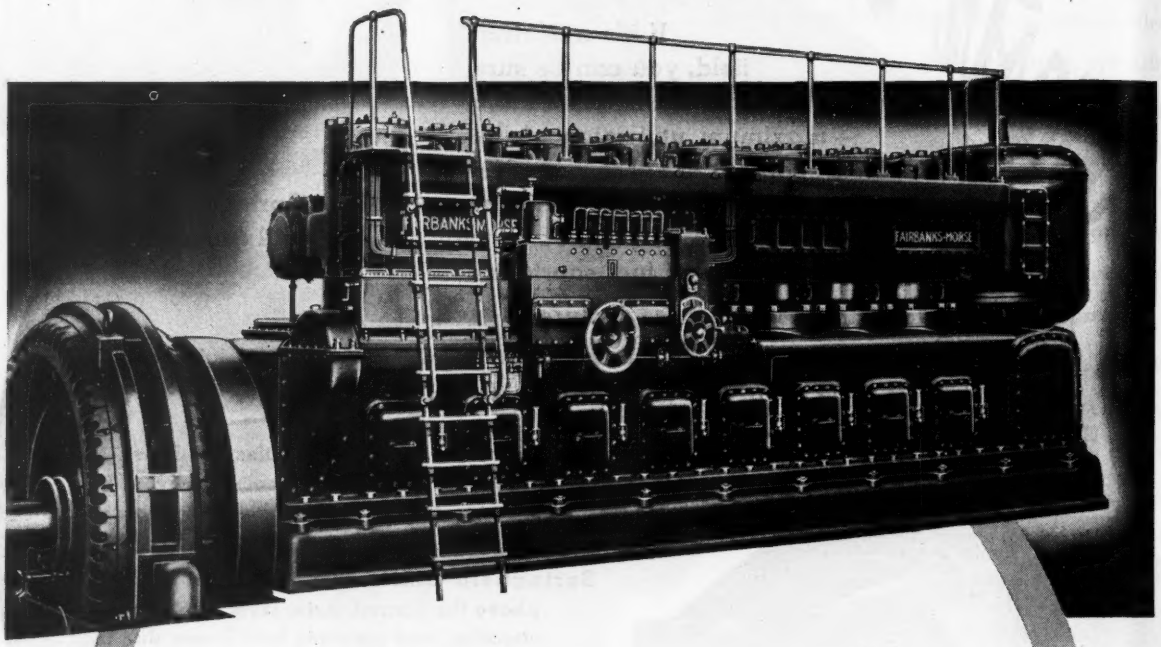
SPRINGFIELD BOILERS

SPRINGFIELD

STEAM GENERATING UNITS
ANY SIZE — ANY FUEL — ANY PRESSURE

FAIRBANKS-MORSE

A name worth remembering



FAIRBANKS-MORSE is the name to think of first when you need Diesel engines. The performance records of more than five million horsepower of these Diesels prove they have the stamina to stand up in sustained, heavy-duty service . . . that they are built for low maintenance cost as well as low fuel cost.

★ ★ ★

The outstanding performance records of Fairbanks-Morse Diesels have been made in every kind of industrial service . . . under every imaginable condition. These great engines have competed against almost every known source of power and come up first.

If you need power, or if you want power that costs less—applied directly or through Diesel-generator sets—ask a Fairbanks-Morse engineer to study your problem.

BUY AND HOLD MORE VICTORY BONDS

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Diesel Locomotives • Diesel Engines
Pumps • Scales • Generators • Motors
Magnetos • Railroad Motor Cars and
Standpipes • Stokers • Farm Equipment

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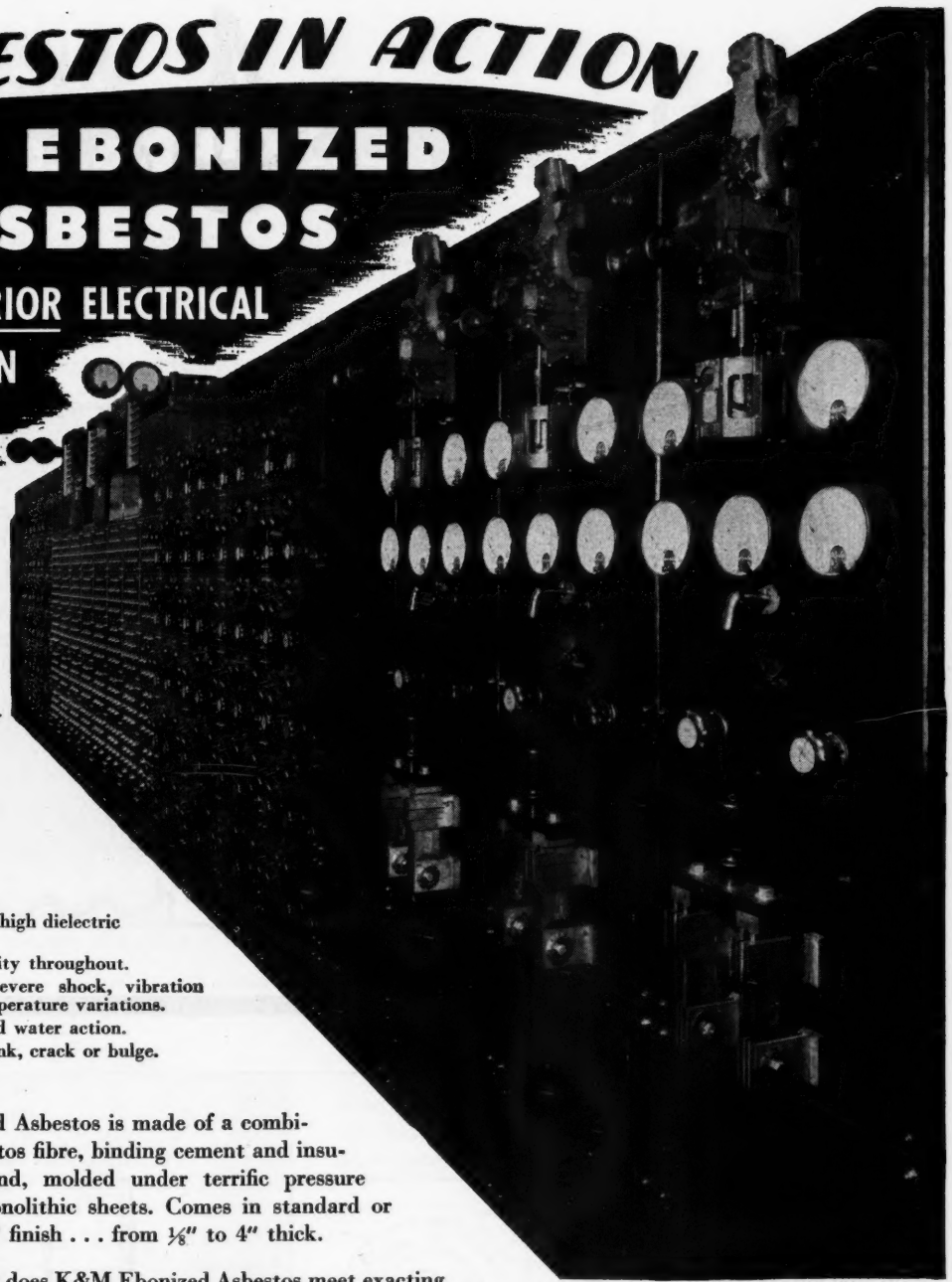
ASBESTOS IN ACTION

K&M EBONIZED ASBESTOS

THE SUPERIOR ELECTRICAL INSULATION

...meets exacting demands



1. Exceptionally high dielectric strength.
2. Uniform density throughout.
3. Withstands severe shock, vibration and wide temperature variations.
4. Resists oil and water action.
5. Does not shrink, crack or bulge.

K&M Ebonized Asbestos is made of a combination of asbestos fibre, binding cement and insulating compound, molded under terrific pressure into strong monolithic sheets. Comes in standard or special "panel" finish . . . from ⅛" to 4" thick.

Not only does K&M Ebonized Asbestos meet exacting requirements for electrical switchboards, but it is ideal for bus bar runs, testing tables, cabinets, bench boards, compartment linings and many other types of electrical installations.

K&M Ebonized Asbestos is specially developed to meet the technical requirements of Underwriters Laboratories, Inc. when built into an assembled unit.

Nature made Asbestos . . . Keasbey & Mattison has been making it serve mankind since 1873.

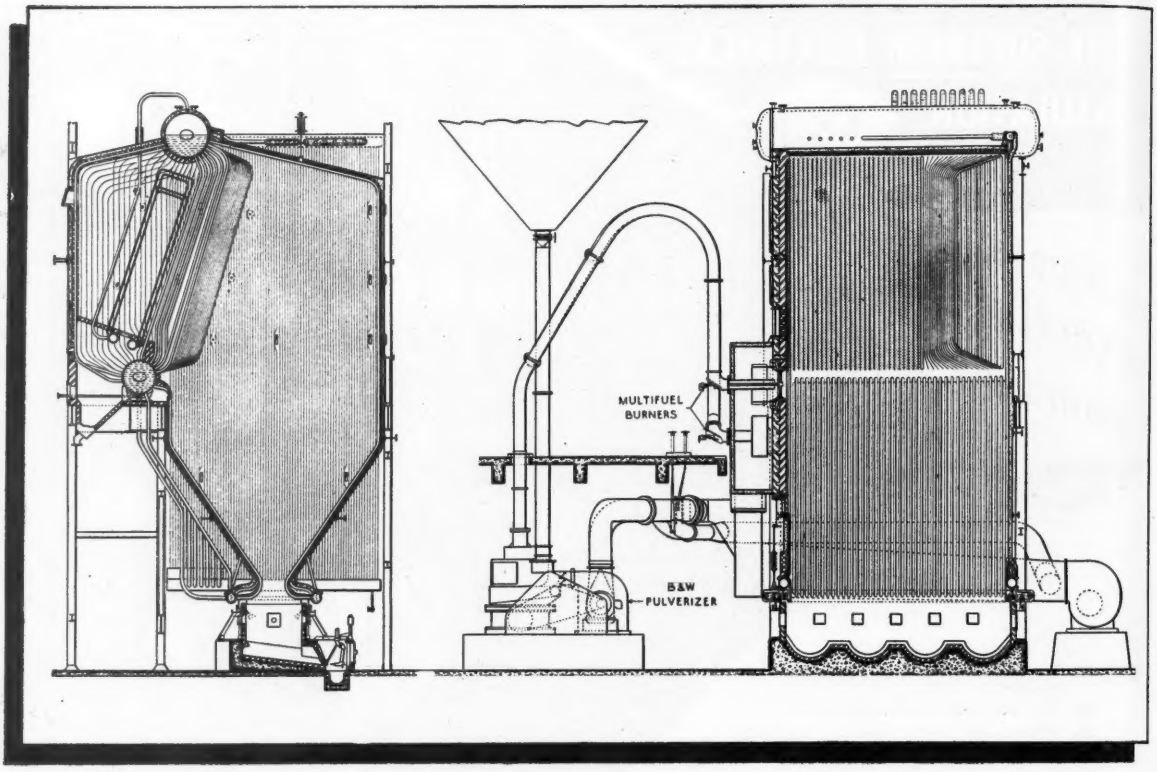
ARMY E NAVY

K&M best in asbestos

KEASBEY & MATTISON

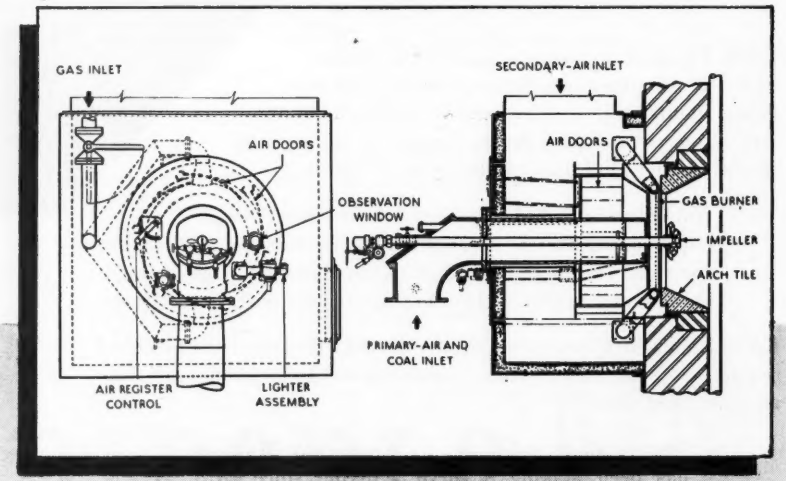
COMPANY • AMBLER • PENNSYLVANIA

Use All Three



Above—Typical B&W Integral-Furnace Boiler arranged for Multi-Fuel Firing.

Right—Details of B&W Multi-Fuel Burner.



with ONE Burner

No need for converting and then re-converting . . . or equipping boilers with *separate* burners for using coal, oil, and gaseous fuels together, or when any one fuel becomes scarce. Changing conditions in fuel needs and availability can always be met when your boilers are equipped with the . . .

B&W MULTI-FUEL CIRCULAR BURNER
for Pulverized Coal, Oil, and Gas

This burner provides in ONE compact unit the features of the B&W Combination Oil and Gas Burner and those of the B&W Circular Burner that is so widely used for pulverized fuels. This combination, properly co-ordinated with furnace and boiler design, provides a wide latitude in choice of fuels:—all grades of coal and petroleum coke in pulverized form, oil, and gas. These may be burned singly or in any desired combination. High combustion efficiency with *any* fuel is assured through turbulent mixing of fuel and air. Let Babcock & Wilcox engineers explain how this equipment can simplify your fuel-burning problems.

Send for Bulletin G-20 A describing this B&W Multi-Fuel Burner and the B&W Combination Oil & Gas Burner.

B&W

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

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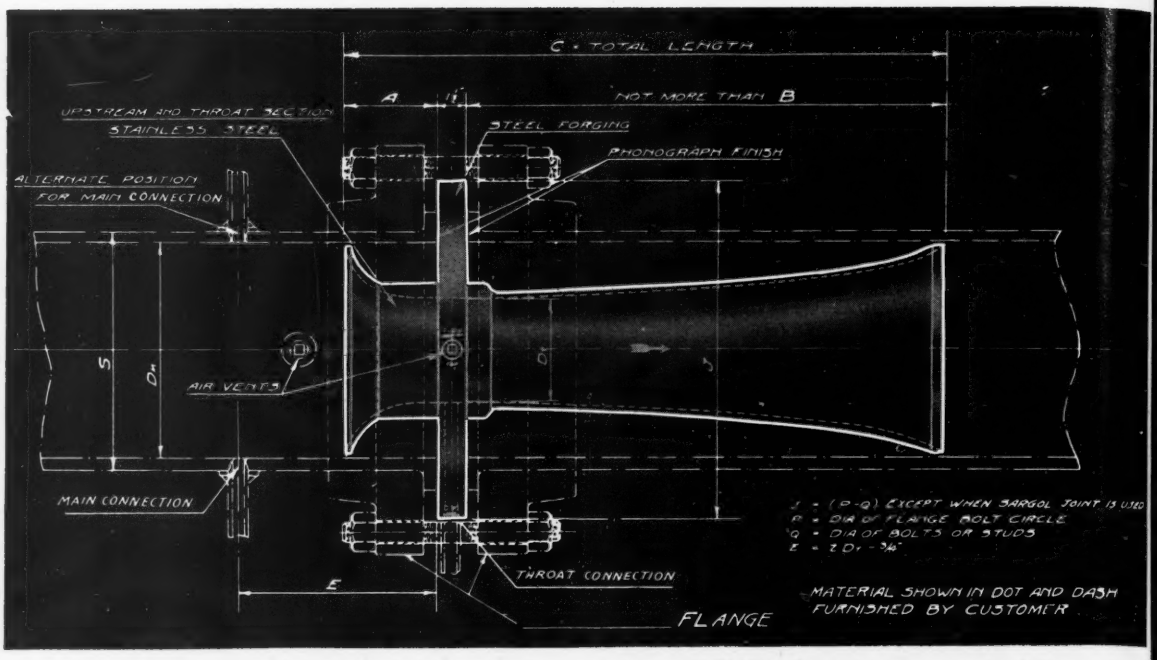


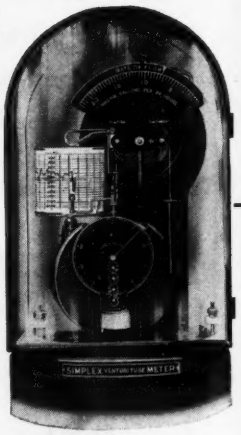
SIMPLEX INSERT VENTURI TUBE (TYPE "TG")

with MO Flow Rate Meter

INSTALLED IN EXISTING LINES... PROVIDES STANDARD VENTURI HEAD QUANTITY

Simplex "TG" Tubes are easily inserted in pipe lines of 3" diameter and up, and provide a convenient, accurate means of establishing differential head characteristics which are as dependable as those obtained from standard Venturi Tubes, with a loss of head considerably lower than in orifice plates.

For high or low pressure lines any required material may be used such as steel, bronze, stainless steel, cast iron, etc. The flange can be furnished to fit any type of pipe joint or welding ring. The cost of a "TG" Tube is relatively low.



THE SIMPLEX MO METER

Simplex "TG" tubes in combination with MO Meters (indicating, recording, totalizing) are widely used for the accurate flow rate measurement of water, oil, gases, air, and industrial liquids. Many power and industrial plants measure fluids of all types with this simple, efficient, primary device and meter, which converts differential pressure heads into rates of flow.

Write today for further information and details of installation of Simplex "TG" Insert Venturi Tubes.

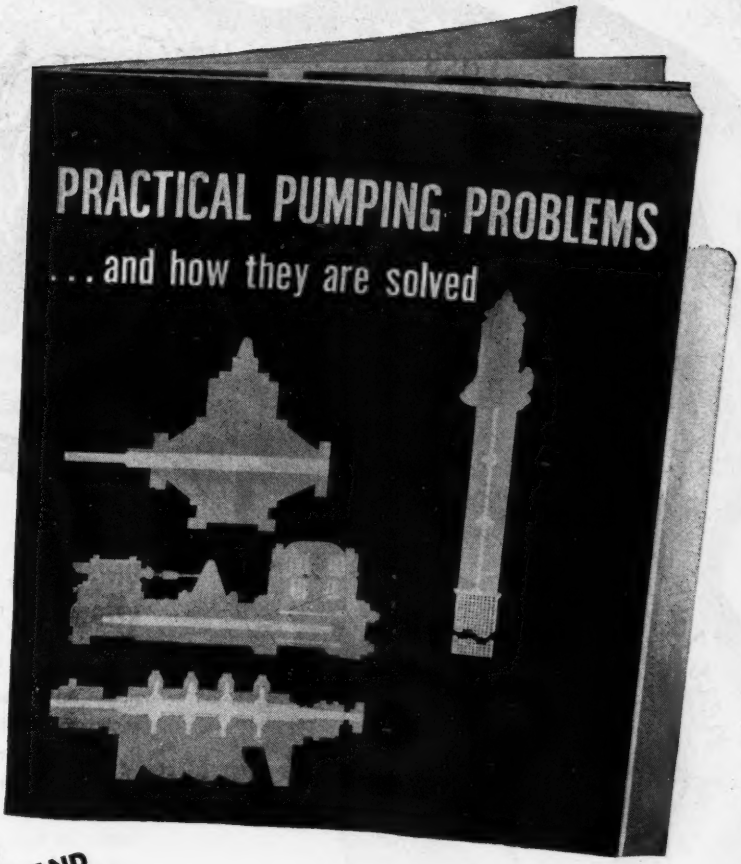
SIMPLEX VALVE & METER COMPANY

6783 UPLAND STREET, PHILADELPHIA 42, PA.

—how can I reduce **CAVITATION OF PUMP IMPELLERS?**

—what metal can we use **TO BOOST THE LIFE OF PUMP LINERS?**

—how can I eliminate **FREQUENT REDRESSING OF MY PUMP SHAFTS?**



—how can I cut down **POWER, PACKING AND MAINTENANCE COSTS?**

—how can I test **THE CORROSION RESISTANCE OF DIFFERENT MATERIALS?**

—how can I get **LONGER LIFE FROM CONDENSER CIRCULATOR PUMPS?**

Here's a booklet that answers all these questions—and *more*. In it, ship and shore engineers give tips on:

How to get 5 to 50 times longer service from vital parts.

How to reduce power, packing and maintenance costs.

How to select materials for handling corrosive sea water and cargoes.

How to solve many difficult pump problems.

plus

General information on pumps written by the associate editors of "POWER" magazine.

You'll find *"PRACTICAL PUMPING PROBLEMS . . . and how they are solved"* a handy reference aid. It shows the many ways Monel* and the other INCO Nickel Alloys can be used to lengthen the life of rods, shafts, sleeves, liners, impellers and other vital pump parts. Send for your copy today.

**Reg. U. S. Pat. Off.*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET, NEW YORK 5, N. Y.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Gentlemen: Please mail me a copy of *"PRACTICAL PUMPING PROBLEMS . . . and how they are solved."*

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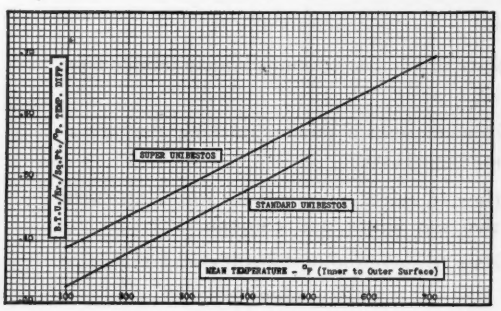
P.P.E. 11-45

UNIBESTOS, THE SECTIONAL INSULATION, KEEPS B.T.U.'s IN THEIR PROPER PLACE . . .

Easy-to-apply Unibestos (it's *the* half-section insulation—just lay one section on the pipe, place the other section under it and—whoosh!—a steel band draws it together firmly, permanently and quickly!) takes the toughest applications in its stride . . . mitres to fit bends and elbows . . . covers flanges and fittings neatly in two simple operations. Unibestos' fibrous nature (it's made of Amosite asbestos) makes for a more perfect seal.

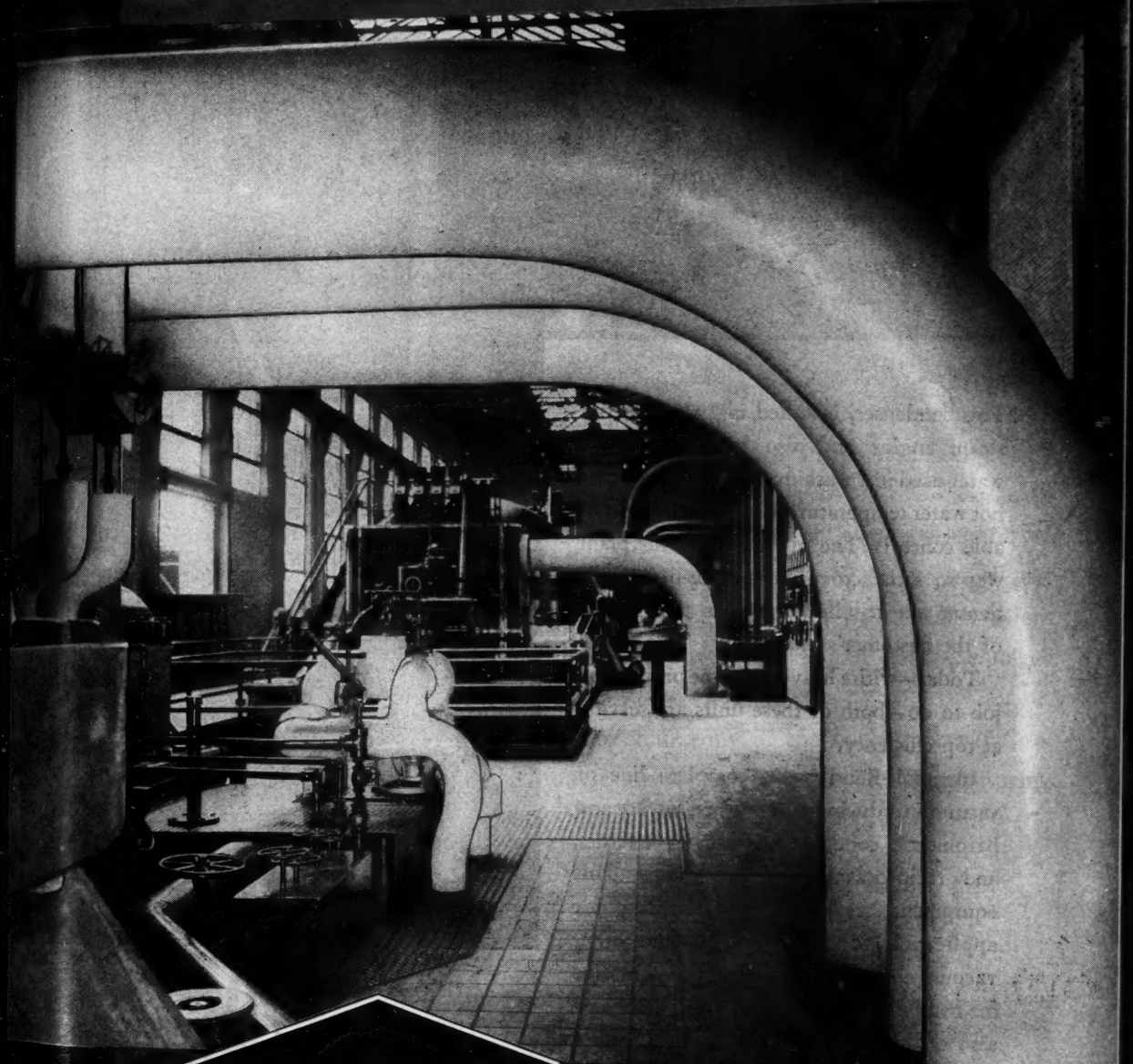
For a step-by-step picturization of the application of Unibestos to steam lines, tanks, nested lines, etc. write for your copy of the magazine "Efficiency"—Bulletin No. 48-974.

These Thermal Conductivity Curves tell the story!



Copyright 1945
Union Asbestos & Rubber Co.

"LOE'S" WON'T STALK THIS PLANT . . .



UNION ASBESTOS
MEANS PROGRESS IN INSULATION
AND RUBBER CO.

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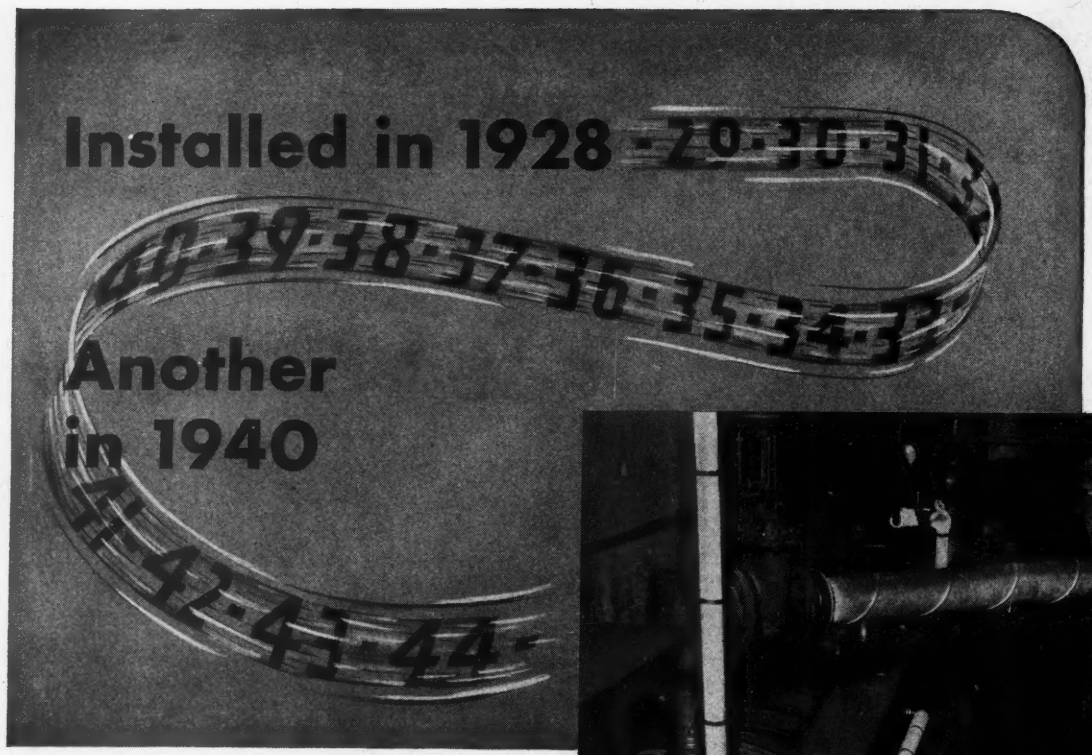

This condenser, installed in 1928, serves a steam engine and also heats circulating water used in a washing process. A constant hot water temperature is maintained by suitable controls. The operation of this plant was so satisfactory, that a duplicate condenser was installed in 1940 in another one of the customer's plants.

Today—with a heavy war-time production job to do—both of these units are serving at top efficiency.

Ingersoll-Rand has a complete line of vacuum-producing equipment—surface and barometric condensers, steam-jet ejectors, and reciprocating vacuum pumps. This equipment has proved its reliability for application to prime movers and other vacuum equipment. Ask our representative for complete details on this equipment and also on pumps, compressors, maintenance tools, etc.

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y.

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COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS

70/30 for CO_2 and O

A hard-temper, phosphorized deoxidized copper tube that failed in a vent condenser installation was submitted to Scovill for examination.

Localized corrosion was found on the outside surface adjacent to the tube sheet where perforation of the tube wall occurred. The remainder of the tube showed no thinning of either the inside or outside and measurements proved the tube still retained its original gauge.

SERVICE CONDITIONS INDICATE WRONG ALLOY

Further investigation developed that the condensate on the outside of the tube contained relatively high amounts of carbon dioxide and oxygen and that there was mild erosion of the tube surface near the tube sheet where maximum flow of the condensate occurs.

Copper is not recommended where erosion may be a factor, so this customer's problem was solved when Scovill recommended 70/30 Cupro-Nickel tubes. In less severe service conditions, an inhibited Admiralty Metal such as Phosphorized Admiralty would resist this type of corrosion better than the copper tubes originally installed.

SCOVILL SERVES THREE WAYS

This case illustrated two of Scovill's three services.

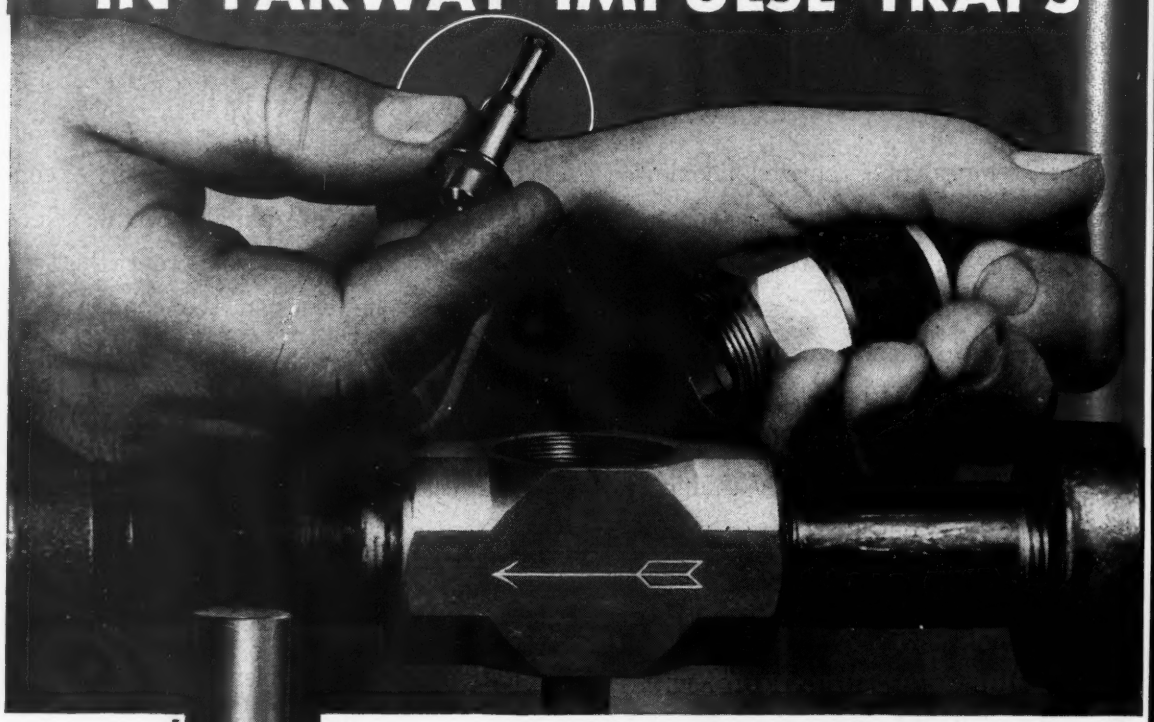
Service in Men provides specialized consultation on tube problems and installation methods. This ties in, as in this case, with *Service in Metals* which covers selection of alloys and study of specific problems in field and laboratory. *Service in Manuals* offers literature on condenser and heat exchanger tubes.

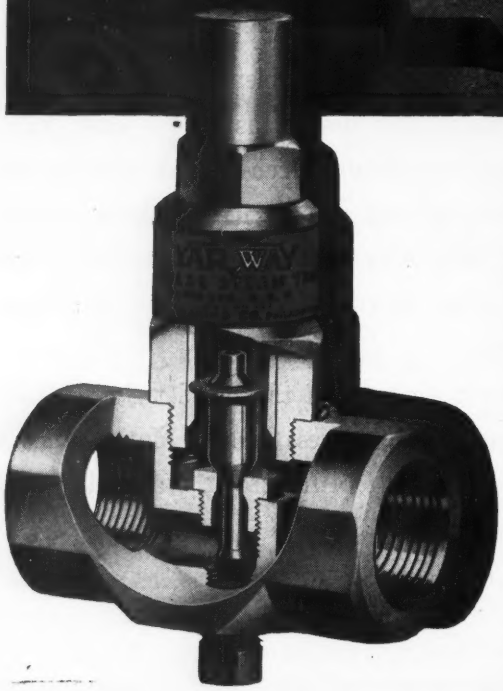
For your copy of the booklet *Scovill Condenser Tubes*, address Scovill Manufacturing Company, 17 Mill Street, Waterbury 91, Connecticut.

Scovill
MANUFACTURING COMPANY
WATERBURY 91, CONN.

CONDENSER TUBES
ONE PRODUCT . . . THREE SERVICES
Service in Manuals . . . Service in Metals . . . Service in Men

The Only Moving Part
IN YARWAY IMPULSE TRAPS





Long life, freedom from repairs and ease of maintenance are three good reasons why more than 400,000 Yarway Impulse Traps have been purchased in the few years since their introduction.

This simple valve—the only moving part—and its replaceable seat—are stainless steel, heat treated. They are good for all pressures.

After years of service, they may be replaced simply by removing the trap bonnet. No need to disconnect the trap from the line. And engineers tell us a handful of these parts will keep a plant full of Yarways in tip-top shape over the years. Far cry from the large inventory of repair parts needed to service other traps.

Maintenance is a major consideration in steam trap selection, of course, but *performance is paramount.* And that is where Yarways really shine. Their continuous discharge on heavy condensate loads gets equipment hotter, sooner, and their intermittent discharge on light loads keeps it hot for maximum operating efficiency, day in and day out.

And when you consider, too, it usually costs no more to install Yarway Impulse Traps than to repair other type traps, why not solve your steam trap problem with Yarways? Write for Bulletin T-1739 or see your mill supply distributor. (More than 100 leading dealers feature Yarways.)

YARNALL-WARING CO. 114 Mermaid Ave., Phila. 18, Pa.

Ask about the new Yarway color and sound motion picture, available for group showings

YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Are Research Scientists People?

By FRANCIS W. GODWIN

THERE has existed a lay tendency to cloak the scientist in a combination of awe, amusement, mystery and black magic, and to set him apart from his fellows. He has been popularly catalogued in the following varieties: (1) Superbrain, making bolts of atomic lightning in a tower in the clouds, (2) a kindly but utterly impractical myopic hermit chasing butterflies and forgetting his lunch, (3) a dangerous crackpot with an insane gleam in his eye and a secret formula for a water substitute, and (4) too frequently, a bearded, white-frocked sage focusing his pince-nez upon a test tube held high at arm's length and uttering product endorsements by the dozen. A more sympathetic but still reserved view held by many conceives the scientist as a well-meaning, likeable, intelligent fellow with a lot of progressive ideas which unfortunately won't work out in practice.

Whatever these freaks may be, if they exist at all, they are not research scientists of our acquaintance. The ones we know are just normal human beings endowed with better than average intelligence, fortified with adequate specialized scientific training, and distinguished from the rest of the upper ten per cent chiefly by their inquisitive instinct, resourcefulness, imagination, and insistence upon logical analysis of everything. If research scientists are rare it is because all of these attributes are needed and the full combination occurs infrequently. Apart from these characteristics—and one or two others which we want to discuss—it proves difficult to write any set of specifications that will bracket them as a group. Some are tall and some are short. Some smoke and some don't. Some take their relaxation one way, others another. Most of them work hard. They vote as they think best, and not necessarily a straight ticket. The usual percentage marry and rear children. Lots of them have vegetable gardens, and we know one who raises pheasants.

But there are some things about the researcher that should be understood if we want his best efforts in behalf of industry. Not that he needs coddling; far from it. But we can at least try to see what motivates him, how he thinks, and what his standards are. We might as well see his point of view. We're going to work with him.

For example, what does he ask as his personal reward? Money? Of course. He wants a comfortable living for himself and his family; and he wants to be able to follow his hobbies, which are often tied in closely with his work. He wants an income commensurate with the things expected of him, and one which will enable him to mingle comfortably with a circle of friends and acquaintances of comparable intelligence and responsibilities in other fields of endeavor. Yet financial reward alone is not enough. For the research scientist is an artist of sorts and, like a painter or a writer, attaches considerable importance to recognition and credit for his accomplishment.

This is a fair demand because his professional development is linked inseparably with the identification of his works, and anonymity robs him of the building stones of his professional reputation. He wants recognition by a jury of his peers. He doesn't ask for newspaper publicity on his research, and nine times out of ten actually objects to it. What he requires is simply dignified acknowledgement in the record. In short, he wants to sign his work with his own name. This is fundamental enough that it has been incorporated into our national patent system, which provides that a patent is valid only if taken out in the name of the inventor himself, even though he may have assigned the entire ownership to another.

A reasonable income. Recognition. Anything else? Yes, one thing more. Everyone wants security, at least to whatever extent security can be reconciled with the desirable spirit of free enterprise. For a researcher, however, a certain degree of security is not only desirable, but necessary. He works almost entirely with his brain, and can't do a good job if beset by extraneous worries. At best, his is a job of many disappointments. He needs encouragement when the going is tough. Never expect to get the most out of a research man by "putting the heat on him." The hard-boiled purchasing agent may be able to speed up deliveries by hinting that he might take his trade elsewhere. The bill collector talks of lawsuits and gets payment on old debts. But make a research man thoroughly uncomfortable, worry him, surround him with arbitrary deadlines, and you'll get absolutely nothing. Try the opposite and you may be surprised.

As to his mental processes, the research scientist is interested in facts—whole facts, undistorted—and he has little use for anything else. He recognizes and respects opinions; he has some himself, but he does not use them as substitutes for facts. With enough concrete evidence before him he can accept the statement that a thing is or is not so, or will or will not work; but without such factual evidence the unanimous verdict of all the experts is to him only unsupported opinion, for the numerical weight of opinions cannot alter facts. This at-

(Continued on page 104)

Dr. Francis W. Godwin, a "charter" member of the Armour Research Foundation, joined its staff in 1937. In 1941, after having guided the Foundation's chemical engineering work for three years, he became Assistant Director, and on June 1, 1945, became Associate Director of Professional Relations. He is also Resident Director in Mexico, where since October, 1944, he has supervised the technological survey being made by Foundation staff members on that country's most important industries He was born in Washington, D. C., September 8, 1910; received A. B. degree from San Diego State College in 1933, M. S. and Ph. D. degrees from the University of Iowa in 1934 and 1937. Dr. Godwin's principal research activities have been in adsorbence, fuels, chemical engineering processes, food products, and ultra-speed photography. He is a member of ACS, AICE, Sigma Xi, Phi Lambda Upsilon, Lambda Delta Lambda and the Iowa Academy of Science. The above material is taken from a booklet entitled To Our Sponsors, prepared by Dr. Godwin to explain to executives just what industrial research is, how it should be regarded by industry and how the Armour Research Foundation provides it.

TOPPING AT HELL GATE

Part I. Detailed description of two-boiler installation supplying 950-psi, 950 F steam to 65,000-kw topping turbine . . . This is first step in topping this famous station; entire program contemplates total of four topping boilers and two topping turbines . . . Each of two open-pass topping boilers can produce 900,000 lb of steam an hour continuously . . . New boilers designed to burn wide range of coals, with ash fluid temperatures as high as 2850 F . . . Pulverized coal firing, 4 mills per boiler . . . Complete details of furnaces and boilers . . . Details of automatic control of attemperator to maintain constant steam temperature . . . Circulation details . . . Firing and draft equipment . . . Shear center beams carry air heater, rear wall and rear pass wall . . . Subsequent articles will describe topping turbine and auxiliaries and unusual steel-work . . . This Hell Gate Installation is a part of the Consolidated Edison Company's general topping program, begun at Waterside No. 2 and continued later at Sherman Creek as described in POWER PLANT ENGINEERING, September, October and November, 1943.

By R. T. Roberts

Assistant Division Engineer
Consolidated Edison Co. of New York, Inc.

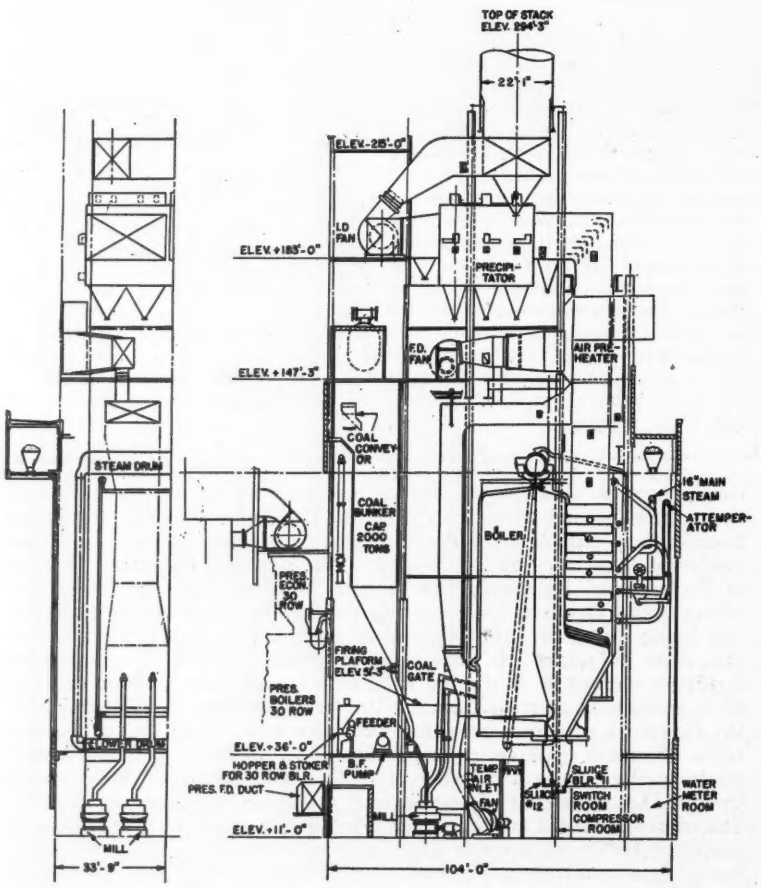


Fig. 1. Cross-section through new topping boiler plant at Hell Gate, showing general arrangement of two 900,000-lb-per-hr, 950-psi steam generating units and auxiliaries

CONTINUING the topping program which the Consolidated Edison Co. of New York, Inc. began in order to modernize the steam generating facilities by replacing inefficient boilers, and to remedy a deficiency in low pressure steam, two new high-pressure boilers, as described here, and a high-pressure turbine are under construction in the Hell Gate station at 134th Street and Locust Avenue. The topping program contemplates two topping turbines and four boilers, of which this installation is the first step.

In the Spring of 1944, the Company was advised by the War Production Board to proceed with design and erection of the first unit. The initial step was the remodeling of the coal handling system which was described in POWER PLANT ENGINEERING in May 1945.

General Design

These two boilers and the 65,000-kw turbine, which they serve, occupy the space formerly occupied by six small boilers and a 40,000-kw turbine, all of which had been sold by the Company for use elsewhere.

Each boiler is designed to deliver continuously 900,000 lb of steam an hour at 950 psi and 950 F at the outlet of the non-return valve, and to deliver 975,000 lb of steam an hour at the same conditions for four-hour periods. Design pressure is 1100 psi. General arrangement of one of the two new boilers is shown in Fig. 1.

The turbine is to exhaust into the existing station 265-psi steam system and provide for about 150,000 kw of low-pressure generation, dependent on which low-pressure generators are used.

The low-pressure turbines operate at 265 lb and 700 F. The lowest inlet steam pressure to the high pressure turbine to give these conditions at the exhaust is approximately 900 lb. If higher pressures were resorted to, reheat became necessary, so the pressure was chosen which gave the lowest basic added cost. Allowing for pressure losses brought the pressure to 950 psi at the non-return valve outlet.

The boilers, Figs. 2, 3 and 5, are of the open-pass type and were furnished, delivered and erected by The Babcock & Wilcox Co. The surface areas are as follows:

Furnace and open pass—23, 440 sq ft
Superheater—32,000 sq ft
Economizer—32,060 sq ft
Air Heater—168,835 sq ft (external)

Boiler and Furnace Details

The steam drum, Figs. 6 and 7, is 72-in. inside diameter, 48-ft-0-in. straight length and has a thickness of 3 13/32-in. An interesting feature of these drums is that they were originally fabricated for the Southwark Station of the Philadelphia Electric Co. and were refabricated by cutting into two pieces and inserting a 72-in. diameter tube approximately 8 ft long between. The drum is fitted with the conventional B & W type cyclone steam separators and scrubber elements.

The water drum, shown in Fig 3 is 30-in. inside diameter, 50-ft-4-in, straight length and is 1¾-in. thick, increased to 2¾-in. for ligaments where necessary.

The two external downtakes between upper and lower drums, Fig. 3, are each 25-in. inside diameter, 1 3/32-in. thick and 74-ft-7-9/16-in. long. To supply water to the tubes in the rear open pass wall and the side water walls of the superheater-economizer section there are two 18 11/16-in. inside diameter 7/8-in. thick rear wall make-up leads, one on each side, connecting the upper header at the rear of the boiler with the external downtakes. Close-up views of the external downtakes during welding are shown in Figs. 6 and 7.

The furnace is entirely water-cooled, with floor, front, side and open-pass walls fed from the lower drum. See Figs. 2, 3 and 5. The front wall above the burners and both side walls are 3-in. O.D. tangent tubes and the lower front wall and floor are 3¼-in. O.D. tubes on 6-in. centers. The open-pass front wall (furnace rear wall) is composed of 4½-in. O.D. tubes on 6-in. centers. These tubes, swaged down to 3-in. O.D., are clustered and bent into line on 30-in. centers at the furnace exit in order to provide a gas passage in which the slag has a minimum possibility of bridging.

The open-pass rear wall is composed of 3-in. O.D. tangent tubes and

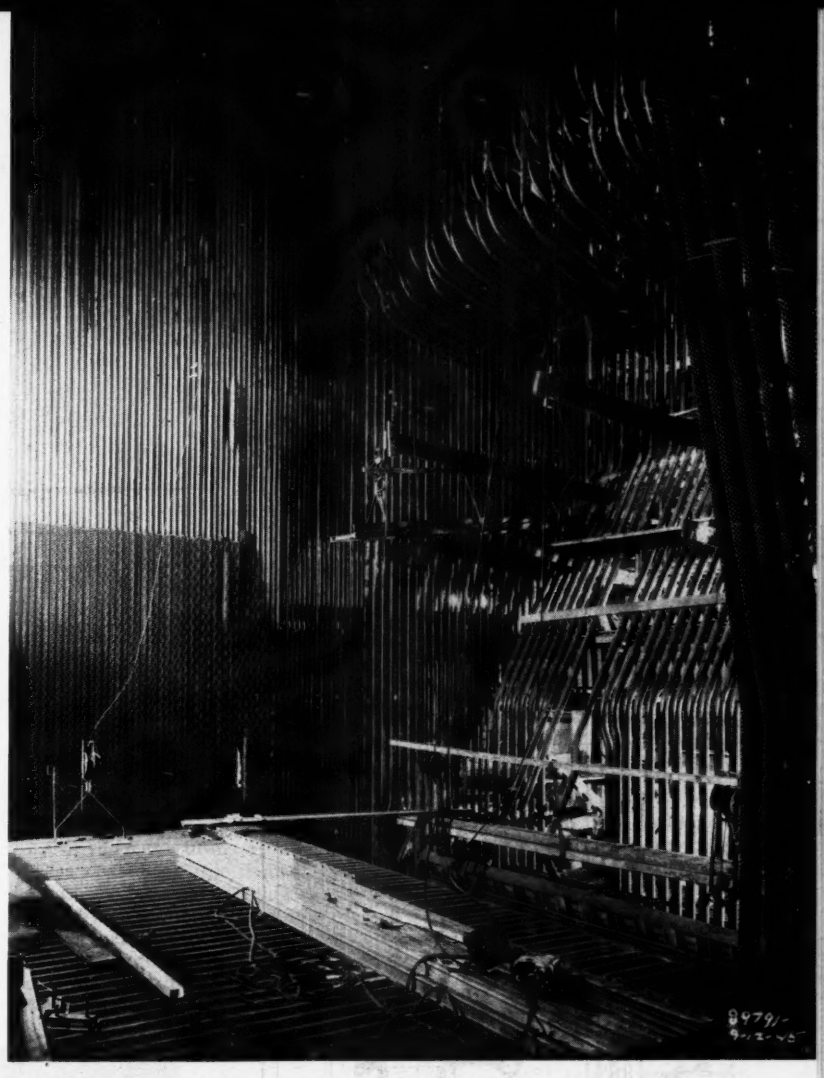


Fig. 2. View of one of furnaces at open-pass front wall, showing furnace floor and side wall tubes, open-pass and superheater-economizer section, superheater screen and rear wall tubes to lower header

is fed with water from the lower header. These tubes form the bottom of the sloping section below the superheater which they screen. At the screen the tubes are arranged 5 deep on 9-in. centers. The side walls of the open pass are 3-in. O.D. tangent tubes.

Slag and dry ash discharge at the bottom of the open pass as shown in Fig. 3. Two slag taps are provided between the furnace and the open pass by bending the front open-pass wall tubes backward into the pass. A water-cooled slag plate is installed below each opening. A flow of gas from the furnace to the open pass, dependent on the draft differential prevents slag from freezing in the openings.

Superheater and Economizer Details

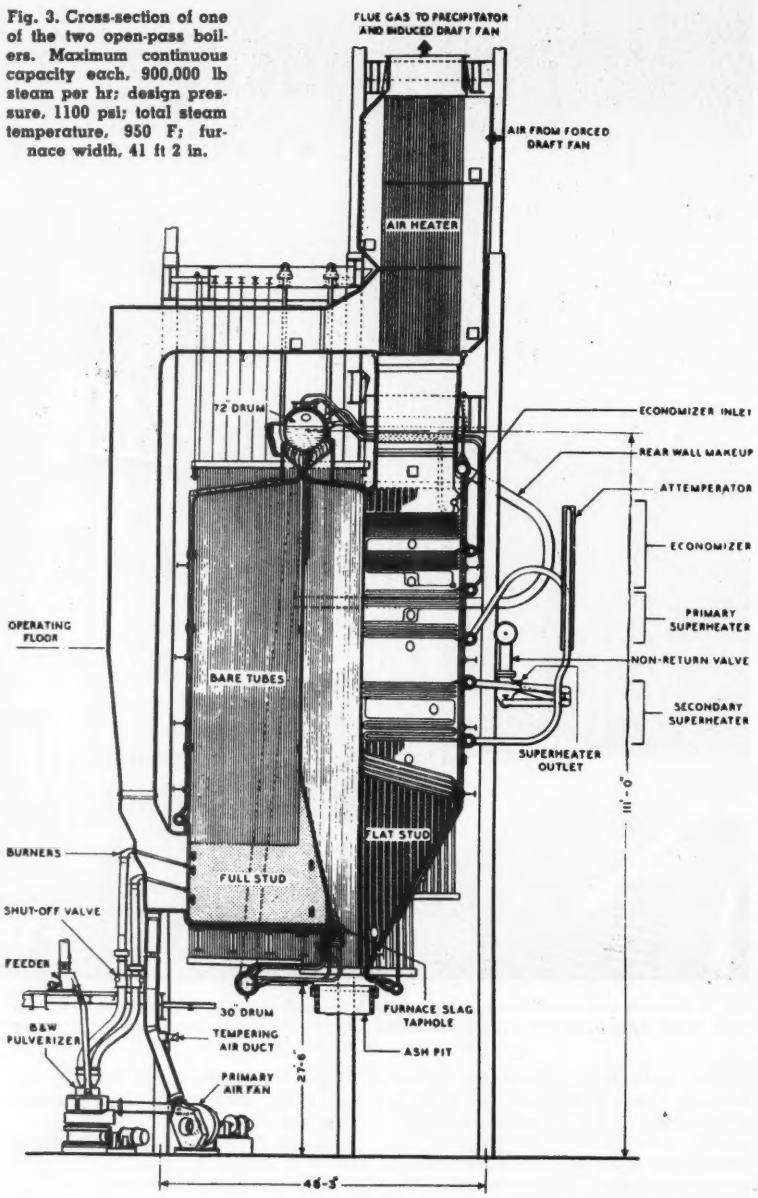
The superheater-economizer convection pass, Fig. 3, has side walls of 3-in. O.D. tubes on 6-in. centers and a back wall of 4½-in. O.D. downcomer tubes on 8-in. centers. In the high-temperature zone at the bottom at the open pass these rear-wall tubes are protected from the heat by the 3-in. O.D. tubes which form the rear open-pass wall.

The superheater is of the continuous loop draining type, and consists of a primary and secondary section. The upper or primary section is connected to the steam drum by 31—4-in. O.D. tubes, and consists of horizontal runs arranged in two banks to accommodate soot blowers. Tubes are 2½-in. O.D. SA-210 on 4-in. centers.

The lower or secondary superheater is composed of horizontal runs of 2½-in. O.D. tubes arranged in two banks to accommodate soot blowers. The last two rows at the outlet end are of Croloy 3 M, the next two rows of Croloy 2, the next row of carbon-molybdenum steel and the remainder of SA-210 steel.

The economizer is designed for 1200 psi and is of the continuous loop-tube type arranged in two sections. The primary section is of 2½-in. O.D. tubes spaced 4 in. horizontally, 16 tubes deep on 3-in. vertical centers. The secondary section is 12 tubes deep on the same spacing.

Fig. 3. Cross-section of one of the two open-pass boilers. Maximum continuous capacity each, 900,000 lb steam per hr; design pressure, 1100 psi; total steam temperature, 950 F; furnace width, 41 ft 2 in.



A vertical tube air heater composed of 2-in. O.D. tubes spaced on 2¾-in. by 3⅜-in. centers is set above the economizer as in Fig. 3. Gas flows inside the tubes which are 38-ft—9⅝-in. between tube sheets. The baffles for air are arranged to form 3 passes. The heater is hung from the top tube sheet with the lower tube sheet floating.

Circulation

The circulation is arranged to take feedwater into each end of the economizer inlet header from which it flows downward (counterflow) through the primary economizer, and then upward (parallel flow) through the secondary economizer and enters the outlet header. This header is connected at each end to the upper boiler drum by 2—6⅝-in. O.D. tubes. The water flows downward from the drum through the external downtakes and enters the lower drum. Furnace floor, front wall, furnace side walls, and open-pass front wall are fed directly from the lower drum. Leads from the lower drum feed the headers into which the open pass side walls are connected.

The rear wall make-up header, which is connected to the downcomers on either side, feeds downward through the rear wall of the superheater-economizer section to a lower header at the rear. This header makes possible the omission of all tubes crossing the ash discharge opening. Some of the rear downtake tubes branch out to feed the lower side-wall headers at the superheater-economizer section.

Steam, separated from the water by the B&W steam cyclones, leaves the drum at the top through tubes which pass through the economizer breeching. These tubes are nested and are enclosed in protective housings to shield them from the gas. They enter the superheater inlet header located outside and across the rear of the boiler.

Steam flows downward (counterflow) through first the primary superheater then enters an intermediate header outside and across the rear of the boiler, from which it leaves through two looped connections, located on the quarter points of the horizontal length, to enter the attemperator.

Details of Steam Temperature Control

Temperature control is accomplished in the attemperator, Fig. 3, from which the steam passes through loops to the intermediate quarter points of the inlet header of the secondary superheater; thence it flows upward (parallel flow) to the outlet header. Two expansion loops, again located on quarter points of the header, lead the steam to the non-return valve.

Temperature control is effected by desuperheating with condensate in the attemperator through six sets of spray nozzles. Temperature control is either automatic or manual from the board and manual locally.

Increase in steam temperature is counteracted by increasing the attemperator spray water flow, opening the spray valves successively. Conversely, decrease in steam temperature is counteracted by closing successive spray water valves. As the attemperator is located between the primary and secondary superheater, steam-temperature equalization is re-established for the secondary or hot section.

The steam temperature from the boiler is controlled by the regulation of spray water to the attemperator in accordance with changes of gas flow, attemperator water flow and steam temperature at the attemperator outlet. Movement of the air-flow pen in the boiler meter sets up an air loading proportional to gas flow

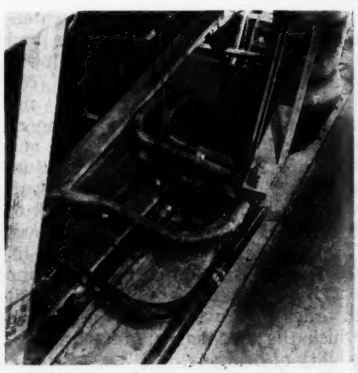


Fig. 4. Lower drum showing supply tubes to furnace side walls

through the boiler. Similarly, movement of the attemperator water-flow recorder pen sets up a second air loading proportional to water flow to the attemperator spray nozzles. The movement of the steam-temperature recorder pen sets up a third loading which increases or decreases with steam temperature. These three air loadings are converted into a single air loading by their respective applications to standatrol and differential relays. The resulting air loading thus produced is transmitted through a hand selector valve and reversing relay to the diaphragm heads of two attemperator spray water regulating valves.

In operations, an increase of load on the boiler, first detected by the action of the air flow element in the boiler meter, varies the loading to the regulating valves in a direction to increase the spray water flow. The attemperator water-flow meter then checks the increase of water flow when the water flow has been brought to an amount proportional to the increase of gas flow. If this change of spray water has been too much or too little for the maintenance of proper steam temperature, the steam-temperature air loading then readjusts the loading dispatched to the regulating valves as required to hold the steam temperature within the desired limits.

Maintaining Attemperator Spray

In order to insure a satisfactory spray in the attemperator, it is necessary to maintain a pressure drop across the attemperator spray nozzles within the range of 25 to 100 psi.

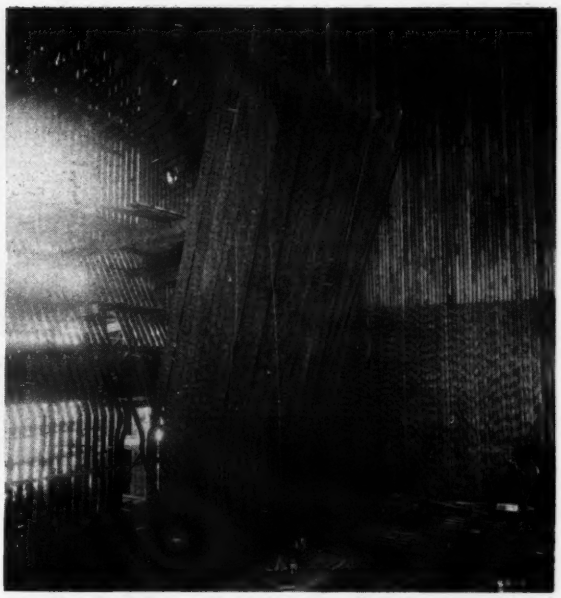


Fig. 5. Looking from furnace toward rear, showing open-pass front wall (with slag opening), floor tubes, furnace side wall, screen tubes under superheaters, rear wall tubes to lower header

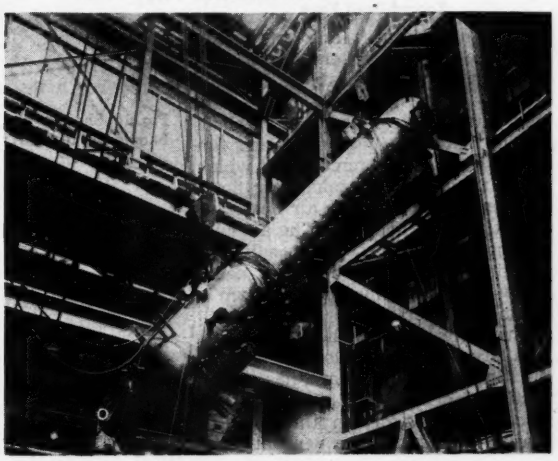
This is accomplished manually by the operator through opening and closing shut-off valves ahead of the spray nozzles. The shut-off valves ahead of the spray nozzles are arranged for remote control from the control room by means of three-way cocks located on the boiler bench board. The operator is guided in this action by observance of a differential pressure indicator which measures the differential pressure across the spray nozzles. To supervise this mutual operation, the differential indicator is arranged to sound an alarm bell if the pressure differential should become less than 25 lb or greater than 100 lb.

A trapping valve is located in each loading line to the spray-water regulating valves and the spray nozzle shut-off valves. These trapping valves are arranged to close and hold the regulating valves in a fixed position in event of air pressure failure.

Coal Handling and Pulverizing

The coal downtake system is a departure from normal practice. The coal is delivered to the mills through downtakes from overhead bunkers located in front of the boilers, Fig. 1. In order to minimize sticking of wet coal, the entire downtake system from bunker openings to feeder inlets is continuously expanding like an inverted funnel. At each joint, the lower section of the pipe is of larger diameter than the section above it, in order that no ledge may exist upon

Fig. 6. Left—Upper drum on floor before hoisting
Fig. 7. Below—Hoisting upper drum



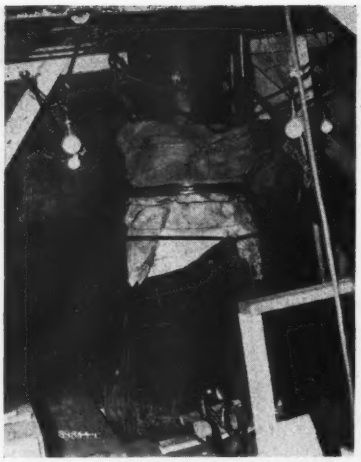


Fig. 8. Preparing to weld external downcomer to lower drum

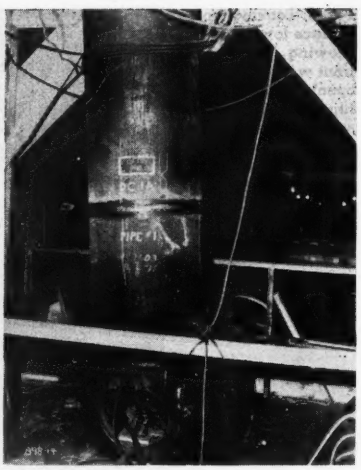


Fig. 9. Welded external downcomer and lower drum

which an arch can form. This necessitated oversized feeder inlets to accommodate the large diameters resultant from the continuous expansion in diameter.

As the boilers are expected to operate with a wide variety of coals, four mills were installed per boiler. These mills each have a capacity of 27,200 lb of 100 grindability coal with a fineness of 80 per cent through 200 mesh, or 22,350 lb of 55 grindability coal with a fineness of 70 per cent through 200 mesh; moisture content in either coal not to exceed 8 per cent. Mills and mill blowers are separately motor driven. Mill temperature is controlled by dampers ahead of the mill blower, the operation of which changes the suction at the blower inlet and admits tempering air in varying amounts through a balanced damper. Feeder speeds are automatically controlled by balancing the pressure in the primary duct against the differential pressure across the mill, which varies with coal level.

Temperature alarms are located in the control room and dampers are remotely controlled from the control board.

Forced-Draft Fans

The forced-draft fans, of which there are two per boiler as in Fig. 1, are located in a room above the boilers and are driven by a single turbine with double-ended driving shaft located between the fans. Each fan discharges into a common duct which forms the air heater inlet. Air flows counterflow through the air heater to an outlet at the bottom. The air duct leading to the burner box splits at the air heater outlet but joins again below the operating floor to form a common burner box.

The room in which the forced-draft fans are located is closed off from the surrounding space and has a floor partially of grating. The air for forced draft is drawn through this grating and thus some ventilation of the boiler room is accomplished and some heat emanating from boiler and air duct surfaces is recovered.

The forced draft fans are American Blower Corporation No 10 DIHS serial 86, each designed for 197,500 cfm at 13-in. H_2O static pressure and 125-F air.

Each turbine has seven impulse stages. The reduction gear consists of a double herringbone gear and pinion having a ratio of 4.9 to 1. Each turbine is rated 682 hp (normal full load) at 5200 rpm with 280 psi abs, 675 F steam to the throttle, exhausting at 22 psi abs. It will develop 1110 hp at 6135 rpm with the same steam conditions.

Pulverized Coal Burners

Firing in each boiler is through eight burners of the cross-tube type, Fig. 3, assembled in a common casing. Each burner is supplied with secondary air from the air duct through a louver type damper. Each burner has a top and bottom secondary air damper, providing shut-off and also directional effect to the flame for slag tapping. Each pair of burners (upper and lower) is fed by a single mill. Ignition is by means of oil from the station oil system.

Burners are directed slightly downward to provide a hot furnace bottom. The products of combustion pass upward through the furnace, through the throat in the first pass wall and down the open pass. They turn upward at the bottom of the open pass and flow through the superheater, economizer and air heater into a common entrance to the precipitator.

Use of Shear Center Beams

An interesting feature of the design is the use of the so-called shear center or eccentric beams, Fig. 10, to carry the air heater, rear wall and rear pass walls. The latter in turn carry the superheater and economizer.

Shear center beams are eccentric in profile and are of the modified channel or modified I-beam shape. The load is carried on the web at the theoretical shear center, so that the torsional moment is thus eliminated. Their use resulted from the close clearance encountered and thus saved space which would be required had the conventional supports been used.

Flue Gas Cleaning

In order to maintain as clear a stack as possible, a Cottrell precipitator, capable of removing 95 per cent of the entrained solid material in the flue gas, was installed. The precipitator is of the horizontal-flow, steel-plate electrode type and is designed for a flow of 417,000 cfm at 340 F.

The dust and fly ash from the precipitator hoppers and points of lodgement in the flues and stack are handled pneumatically and discharged into the existing station sluice system in the basement. A hydrovactor located near the sluice creates the required vacuum for the ash system and provides a wetting medium for the ash as it enters the sluice. An automatic valve remotely controlled from the ash control board at the precipitator level opens the water line to the ejector. The system is arranged to operate through automatic control, with the changeover from one loading

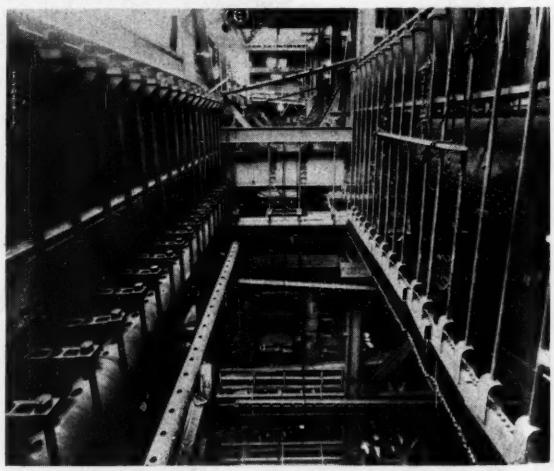


Fig. 10. Shear center beams below air heater

Principal Boiler Plant Equipment in Hell Gate Topping Unit No. 1

Steam Generating Units: 2—The Babcock & Wilcox Co. open-pass units, single set, each with primary and secondary continuous-tube superheaters, primary and secondary continuous-tube economizers, and tubular air heater. Steam generating capacity 900,000 lb per hour each at 950 psi, 950 F continuously, 975,000 lb per hour at 950 psi, 950 F for four hour periods. Boiler furnace and open pass 23,440 sq ft, superheater 32,000 sq ft, economizer 32,060 sq ft, air heater 168,835 sq ft external surface. Multiple burners, set in 2 rows of 4 each, each upper and lower served by one type E 56 mill. Each of the four mills per boiler driven by a 100-hp, 2300-v, 600-rpm G E motor; 4 mill blowers per boiler—B F Sturtevant No. 52-½-57, Arrgt 8—14,500 cfm, 420 F, 25.7 in. static pressure ring-oiled, water-cooled bearings, shafts equipped with heat slinger discs. Each mill blower separately driven by a 100-hp, 2300-v, 1800-rpm G E motor. Steam temperature controlled by B&W spray-type attemperator with Bailey Meter Co control.

Precipitators: 1—Cottrell precipitator per boiler, manufactured by Research Corp, designed for 95 per cent removal when handling 417,000 cfm at 340 F; three sections long, steel-plate electrodes with 4 electrical sets each, operating at half wave on the first two sections, full wave on last section.

Induced-Draft Fans: 4—B F Sturtevant, 2 per boiler; No 1010 double-inlet double-width with erosion-resisting wheels, floats self cleaning, partially forward curve with radial tip, water cooled bearings, flood lubricated from turbine oil pump, designed for 267,500 cfm at 16 in H_2O and 375 F gas at 770 rpm.

Induced-Draft Fan Drives:—Two fans of each boiler driven by a single G E Co. turbine with double-ended driving shaft—Turbine rating 2090 hp at 6000 rpm with 280-psi abs. 675-F steam and exhausting at 22 psi abs., 7 impulse stages, double helical gear and pinion reduction—ratio 7.7 to 1.

Forced-Draft Fans: 4—American Blower Corp. No. 10 special H.S. serial 86 fans, 2 per boiler; double-inlet, backward-pitched blades, each designed for 197,500 cfm at 13 in H_2O and 125-F air at 1267 rpm. Water-cooled bearings, flood lubricated from turbine oil pump.

Forced Draft Fan Drives:—Two fans of each boiler driven by a single G E Co. turbine with double-ended driving shaft. Turbine rating 1110 hp at 6135 rpm with 280 psi abs. 675-F steam and exhausting at 22 psi abs., 7 impulse stages, double helical gear and pinion reduction-ratio 4.9 to 1.

Fly Ash Handling:—United Conveyor Corp. pneumatic system with loading points at precipitators and flue hoppers, discharging to station sluice system. Vacuum produced by hydraulic ejector, with remotely controlled water valve and remote automatic and manual sequence control from control board at precipitator level, capacity 15 tons ash per hour.

Slag Handling System:—Single sluice for each boiler, discharging to station sluice system. United Conveyor Corp. hoppers, refractory lined with side wear plates. Water capacity 5000 gpm each.

Combustion Control:—Hagan Corp. arranged to regulate induced and forced-draft fan turbine speeds and coal feed to maintain steam pressure.

Feedwater Control:—Bailey Meter Co. three-element control, operating main feed valve on each boiler.

Control Bench Board & Panel:—Light gray lamicoid covered plywood, black formica trim on structural steel frame. Fabricated by Fiske Iron Works.

Chemical Feed Pumps:—HP-Boiler Installation: 3 Proportioneers Inc. duplex chemical feed pumps, 30 gph capacity at 1500 psi gage maximum discharge pressure with 150 F chemicals. Stainless steel cylinders, plungers and valves. Driven by 5-HP, 250-v, d-c, variable-speed motor, 1750 to 175 rpm, through a 5-kw, 250-v, d-c generator with 10-hp, a-c squirrel-cage motor, controlled from chemist's table.

Chemical Feed Pumps: Make up water: 2—Proportioneers Inc. Treet-O-Unit proportioning pumps, actuated by Treet-O-Control propeller type meters in proportion to make-up demands. Feed rate—30 gal per million pounds metered water, discharge pressure 5 psi gage.

Soot Blowers:—Diamond Power Specialty Co., 1K model retractable; 2 per boiler on inside aisle, 2 telescopic type per boiler on outside aisles in pass and between first and second superheater banks; 4 G 9 B Clyde nozzle each side between second and third superheater banks; and 2 G 9 B mass blowers per side between third and fourth superheater banks, superheater and economizer, and first and second economizer banks.

point to another in the system being controlled by changes in line pressure, or by hand control of individual loading points.

Slag Removal

The slag from the furnace and dry ash from the open pass are discharged from the bottom of the boiler as shown in Fig. 3. As previously stated, the slag runs from the furnace through two openings in the open pass wall and discharges over a water-cooled lip. It drops from the lip into a trough located below the boiler. Dry ash and slag dislocated from the pass by blowing also fall into this trough, which is continuously sluiced with low pressure water. The trough is protected on the side, where subject to slag fall, by a hard iron plate and the sides are continuously sprayed by water to prevent adherence.

A grizzly over the entire length of the trough is provided, on which large lumps may be reduced. Doors for inspection and slag breaking are provided along the length. An access door is provided at the head end. The top of the trough is designed to form a water seal and accommodate the downward movement of the boiler when hot. Each boiler sluice trough discharges separately into the existing station sluice system.

Induced-Draft Fans

Two induced-draft fans are installed per boiler, Fig. 1, each capable of handling 267,500 cfm at 16-in H_2O static pressure and 375 F. The fans are B F Sturtevant No 1010 Design DIDW with erosion-resisting wheels. The center plate of these wheels is cut away between the blades, so that there is no metal to be eroded by fly ash. Wheels are designed to be interchangeable with other fans in the station.

Two fans are driven by a single turbine with double-ended driving shaft located between the fans. The turbine has seven impulse stages. The reduction gear consists of a double herringbone gear and pinion having a ratio of 7.7 to 1. Each turbine has a normal rating of 1304 hp (normal full load) at 5110 rpm with 280-psi abs. 675-F steam to the throttle and exhausting at 22 psi abs. Each will develop 2090 hp at 6000 rpm with the same steam conditions.

Each pair of fans discharges through flues to the stack. Worthy of mention is the fact that the fans were set out of synchronism so that, as one blade in one fan is at the cut-off point, the blade of the other fan on that boiler is at half the blade spacing from the cut-off point. This setting is to prevent creating any harmonic which might be amplified by the flues and stack.

Soot blowers are provided to clean the open pass, superheater and economizer sections. In the open pass, the soot blowers are retractable on the sides toward the center aisle. On the other side of each boiler, telescopic blowers were used due to limited space conditions.

The air-heater tubes are arranged for washing from the top. The breeching between the air heater and economizer is provided with members for supporting tarpaulins to catch the water, from which it runs to fixed drains and is led outside of the breeching to a drain system.

Boiler Controls

The control room is located on the west side of the boiler room on elevation 38-ft-10-in. Provision for the control of the next two boilers has been made in this room. The control equipment is arranged on a bench board and vertical panel. An auxiliary alarm, temperature and a valve control panel is also located in the control room.

The bench board is arranged with a central section, which serves as a desk and telephone station, and the controls for each boiler occupy either end. From here are remotely controlled the attemperator spray-water valves, mills, mill feeders, mill blowers, forced and induced-draft fans, feedwater valves and desuperheater pressure reducing valve.

The vertical panel consists of a central panel for the instruments which are common to the installation, such as the indicating and recording of pressure and temperature in deaerator, desuperheater, low pressure steam and boiler feed. The draft gages, pressure gages and recorders for each boiler occupy panels on either side of the central section.

An alarm panel is arranged to signal pertinent high and low pressures, temperatures and levels throughout the installation as well as failure of combustion control air and grounds on certain electrical equipment.

A second panel carries the temperature recorders for steam, gas and air for the installation.

The combustion control was furnished by Hagan and is arranged to regulate air flow, furnace draft and coal feed to maintain steam pressure.

Bailey Meter Co. three-element feedwater control is provided to oper-

(Continued on page 81)

The Application of Power-Line Carrier

A short, practical demonstration of Power-Line Carrier—What it is, How it works, and What it can do. Carrier current systems have been in use on utility power lines for many years but, usually, only those concerned directly with their operation are very familiar with them. This article written specially for us by Mr. Cheek, is designed to give others, those not directly concerned with "carrier", a workable knowledge of this interesting and useful system of communication and control.

By R. C. Cheek **Central Station Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.**

POWER-LINE CARRIER is by no means a new tool to power-system engineers. It has long since proved its reliability and indeed its indispensability in a wide variety of power-system applications. However, advances in electronic engineering during the past few years have resulted in new applications of power-line carrier that greatly extend its field of usefulness.

A modern power-line carrier system like that shown in Fig. 1 can perform such diverse operations as telephone communication, fault detection, load control, telemetering and sleet detection. All or any desired combination of these functions can be handled by a single carrier installation. A unit system which permits new functions to be added or old ones expanded provides a flexibility which allows for almost any conceivable power system growth. For this reason there has already been a great increase in the number and variety of power-line carrier applications, and the postwar plans of many utilities include installation of extensive carrier systems.

What Is Power-Line Carrier?

In a typical radio broadcasting system, high-frequency energy generated by a transmitter is conducted by a radio-frequency transmission line to an antenna system, which radiates the energy into space. The energy travels through space, subject to the whims and vagaries of atmospheric conditions, until it reaches the receiving point or points at a minute fraction of its original magnitude. At the receiving point it is intercepted by an antenna which transmits it through another transmission line to the receiver, where it must be greatly amplified before it can be used.

The only fundamental difference between a power-line carrier system and a space radio system is that the transmitting and receiving antennas are eliminated, and the gap between them is closed. The transmitter feeds the receiver directly through a highly reliable and well protected transmission line—the power transmission line itself. Radio-frequency energy is not radiated into space but is guided along the transmission line directly to the receiving point without being radiated.

The frequencies normally used for power-line carrier lie in the band from 50 to 150 kilocycles as shown in Fig. 2. Currents of these frequencies can be introduced into a high-voltage power line through coupling capacitors (Fig. 3), which are series tuned to allow carrier currents to pass freely, but which act practically as insulators to the 60-cycle voltage. Series-tuned coupling capacitors can be used to by-pass carrier signals around line sectionalizing points. This provides a continuous channel regardless of whether the circuit is closed for 60-cycle currents.

Carrier-frequency currents can be directed to desired line sections by means of line traps like that in Fig. 4, which consist of parallel-resonant circuits, tuned to carrier frequency and inserted directly in series with the power conductors. The traps offer a high impedance to carrier-frequency current but have no appreciable effect on 60-cycle current. They are placed in series with taps and spur lines which are not part of the desired

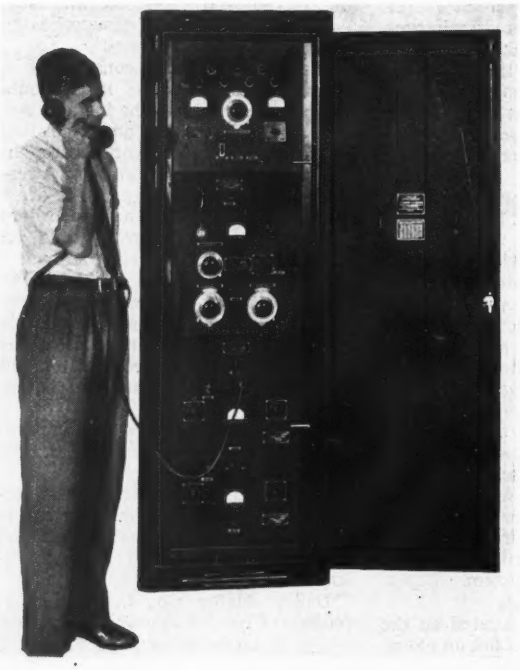


Fig. 1. This power line carrier installation combines the functions of communication, relaying, telemetering, and sleet detection

route for the carrier channel and which might cause needless absorption of the carrier energy. A typical installation of coupling capacitors and line traps is shown in Fig. 5.

There is no fundamental difference between radio transmitters and receivers and corresponding power-line carrier apparatus. Power-line carrier transmitters and receivers use time-tested circuits and tubes familiar to every radio engineer. Power outputs required for power-line carrier are comparatively low, making it possible to use receiving-type tubes for transmitting in many applications. Carrier signals are conducted directly to the receiving point without radiation, and received signal levels are usually much higher than the normal levels encountered in radio work. As a result, carrier receivers are in general less sensitive and much simpler than radio receivers. For some applications a single-tube receiver is entirely adequate.

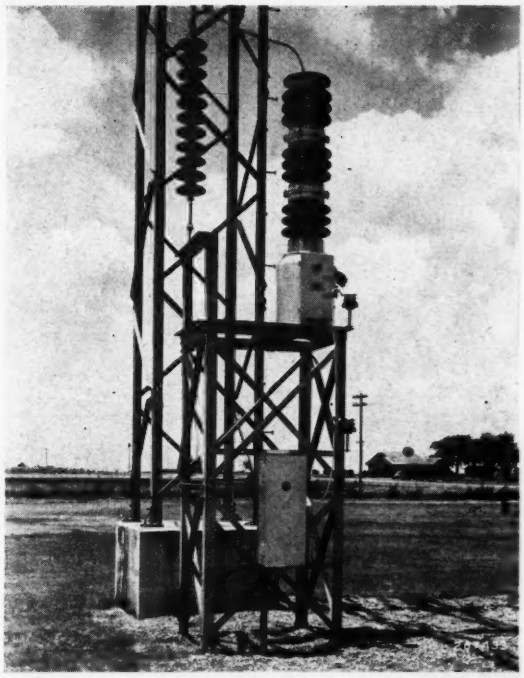


Fig. 3. Coupling capacitors like this introduce currents of carrier frequency into the transmission line

Power-Line Carrier Communication

The earliest applications of power-line carrier were for telephone communication between stations on a power system. Power-line carrier communication has since then been developed to such a point that for all practical purposes it is possible to duplicate with it the service obtainable on commercial automatic telephone exchanges. For example, the automatic simplex communication set shown in Fig. 6 provides selective dial calling to any extension at any station including other extensions at the same station. There may be as many as ten stations on a single carrier frequency, each having up to ten extensions. One or more of these extensions may be to a private branch exchange, which can tie the carrier system to a local system and multiply the extensions almost indefinitely.

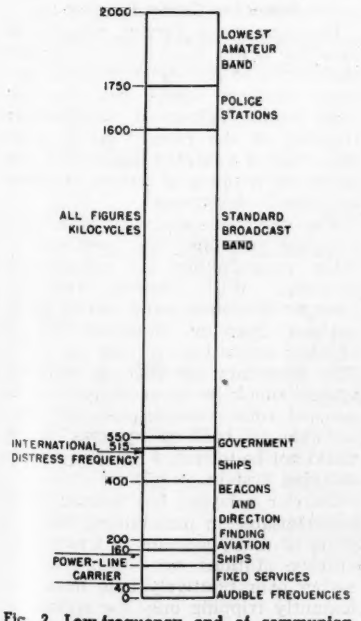


Fig. 2. Low-frequency end of communication spectrum showing relative position of power line carrier frequencies

The automatic simplex system provides nearly every feature found on modern dial telephone exchanges plus some additional features. To make a call, a person simply picks up his handset and dials the number of the extension desired in the usual manner. Only the telephone on the desired extension rings at the selected station. The calling party receives a "ring-back" signal during this process, an indication that the equipment is functioning properly and that ringing voltage is being applied to the desired extension at the remote station. When the called party picks up his handset, ringing stops immediately and the channel is ready for conversation. If during this conversation a telephone on any other extension is picked up, it will receive a busy signal. A special feature called "preferred service" can be provided for selected extensions such as the load dispatcher's office. A party at a preferred service extension, instead of receiving a busy signal if the channel is busy, can break directly into a conversation and ask for immediate use of the channel. The main components of an automatic simplex system are shown in Fig. 7. In this system all stations transmit and receive on the same frequency. At a given station the receiver is blocked and the transmitter is turned on by an automatic electronic transfer unit at the instant the party at that station begins to speak. When he completes his statements, the transmitter is automatically turned off and the receiver is turned on to receive the other party's reply.

Several methods of ringing are available for power-line carrier telephone systems, in addition to the selective dial system desired. Code bell ringing is frequently used. Code bell ringing is the system often used on rural party lines in which all telephones are rung, the desired extension being indicated by coded long and short rings. The calling party rings by turning a magneto-type generator or by pressing a ringing key. The telephones at all extensions ring in accordance with the transmitted code.

Another method of calling which is even simpler than code-bell ringing is automatic ringing. In this system the telephones at the receiving end ring when the calling party picks up his handset. This ringing may be continuous but if desired, can be made to last for a few seconds and then is automatically cut off. If the called party answers before the end of the ringing period, ringing is stopped immediately. This system is generally suited only to point-to-point channels, because it is the presence of the carrier signal on the channel that causes ringing.

A third system of calling is voice calling. In this system, the calling party merely picks up his receiver and calls the other station by name. The output of the receiver at the called station operates a loud speaker, which is automatically disconnected when the party at that end picks up his handset.

The two-frequency duplex system is often used where direct communication is required between two points only. In this system one station transmits on a frequency which is received at the other station. The second station transmits on another frequency

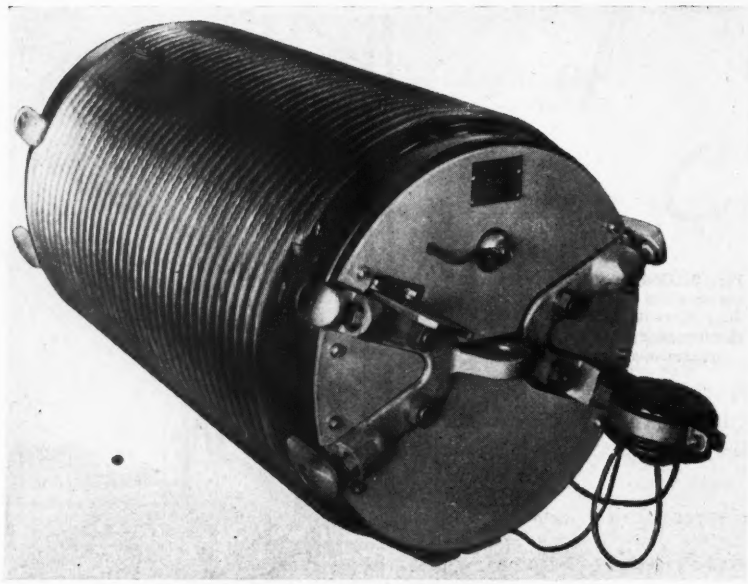


Fig. 4. Line traps similar to this offer a high impedance to carrier frequencies and thus prevent transmission of carrier intelligence over branch circuits and tap lines

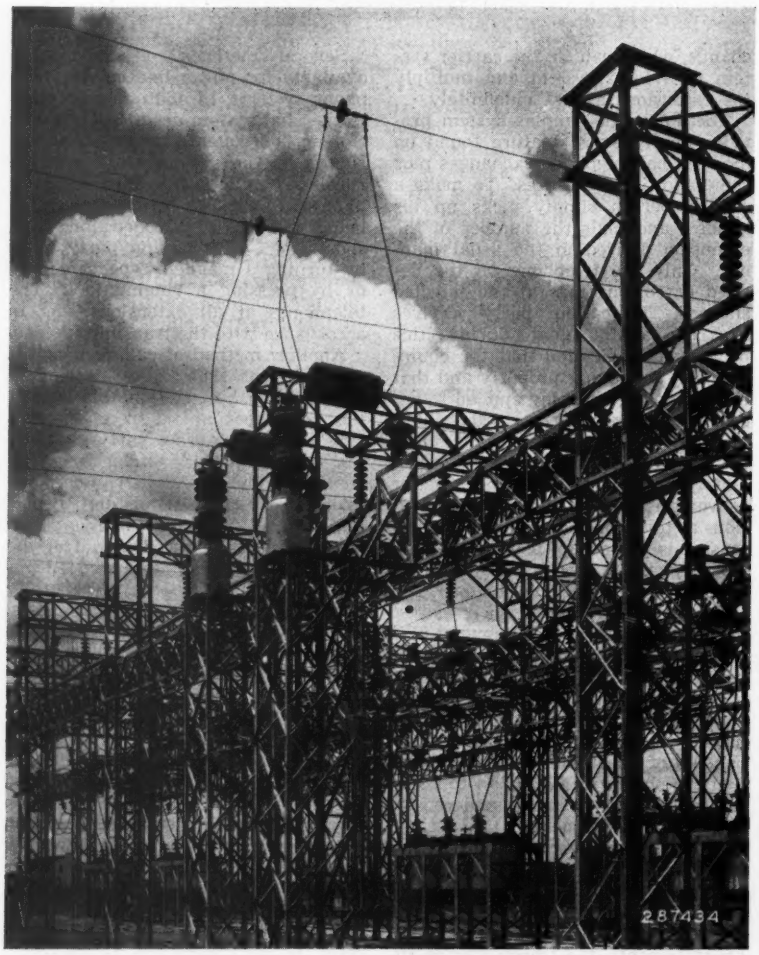


Fig. 5. Installation view of coupling capacitors and line traps. The coupling capacitors are the link between the carrier set and the power line. The line traps prevent transmission of carrier energy in unwanted directions

which is received at the first station. Both transmitters and receivers may operate continuously during the conversation, making the electronic transfer unit described for the automatic simplex system unnecessary.

Although the two-frequency duplex system is intended to be used normally for communication between two points only, it is possible to connect two such channels in series so that communication can be obtained between other points. The two-frequency duplex system is well suited also for communication from one central point, such as a dispatching office, to a number of other points which do not normally require direct communication among themselves.

Two-frequency duplex communications is normally arranged for several extensions at each station, and it can also operate into a PBX board to multiply the number of extensions available.

The single-frequency manual simplex system is less elaborate than any of the systems so far described. It is a "push-to-talk" system, in which the party desiring to speak pushes a button on his handset to start his transmitter, and releases the button to listen to the other party's reply. D-C control circuits and push-button handsets are required, making this system unsuitable for operation through PBX boards. However, where extensions are few in number and operators are accustomed to handling the equipment, this system is often entirely adequate for routine and emergency communication, where a minimum of equipment is desired. This system also has the advantage that direct communication among all stations on a channel is possible. Code bell calling is normally used.

Power-Line Carrier Relaying

In many ways carrier relaying is ideal for power lines too long for the application of pilot-wire relaying systems. Modern carrier relaying systems permit high-speed simultaneous tripping of the circuit breakers at both ends of a faulted line section but block the tripping of circuit breakers on unfaulted sections.

The extreme selectivity of carrier relaying simplifies the problem of relay co-ordination on complicated systems. With carrier relaying, changes in system setup can be made without fear of improper circuit breaker operation in case of fault. The secondary or back-up relaying system should be co-ordinated, but in general some compromises are permissible in back-up systems which could not be tolerated for the primary relaying system.

Carrier relaying has proved itself indispensable in maintaining the stability of many systems in which generating stations are connected together over relatively long lines. By instantly tripping only the section of a line on which a fault occurs, carrier relaying removes the fault in the

shortest possible time and permits synchronizing power to continue to flow in all unfaulted lines. The result is that shock to the system and resulting swings are minimized and maximum stability is obtained. Efficient use of high speed reclosing of circuit breakers dictates the use of carrier relaying for prompt fault isolation. Maximum advantage can be taken of the rapid interrupting ability of modern circuit breakers only with the fast relaying provided by carrier.

Several types of carrier relaying systems are available. One of these, a distance-type system using impedance relays was introduced in 1936 and has had a wide acceptance in the central station industry. This system provides all the advantages of carrier relaying plus distance step-type back-up protection. With slight modifications it can be used with a new long-line relay. This relay is similar to the ordinary impedance relay but includes additional means of distinguishing true fault currents on long lines from load and charging currents and currents resulting from system swings.

A new carrier relaying system, recently announced, is especially useful for application to existing lines where relays already installed can be used for back-up purposes. This system is giving great impetus to programs for speeding up fault clearing times, because it makes maximum use of existing relay equipment with a minimum of additional apparatus. A single relay, with only two moving parts, detects and clears all types of phase and ground faults. An important feature of the system is that no source of line potential is required. A complete installation of this carrier system at an existing line terminal therefore requires the addition of only one relay, a carrier transmitter and receiver with its coupling circuits, and an electronic control unit which is mounted with the transmitter and receiver.

Fig. 6. A single-frequency automatic simplex carrier communication installation which permits dial calling to any extension at any station

The primary purpose of a carrier relaying scheme is to insure rapid clearing of faults of all kinds; therefore, it is essential that these faults shall not interfere with the functioning of the carrier. For this reason, carrier transmission must be required only over unfaulted line sections. In modern carrier relaying systems this requirement is met, because it is the *absence* of carrier on a faulted line that permits instantaneous tripping to occur. The carrier signal is used only to *prevent* instantaneous tripping on unfaulted line sections.

An application of carrier for relaying purposes that has grown in importance recently is remote or trans-

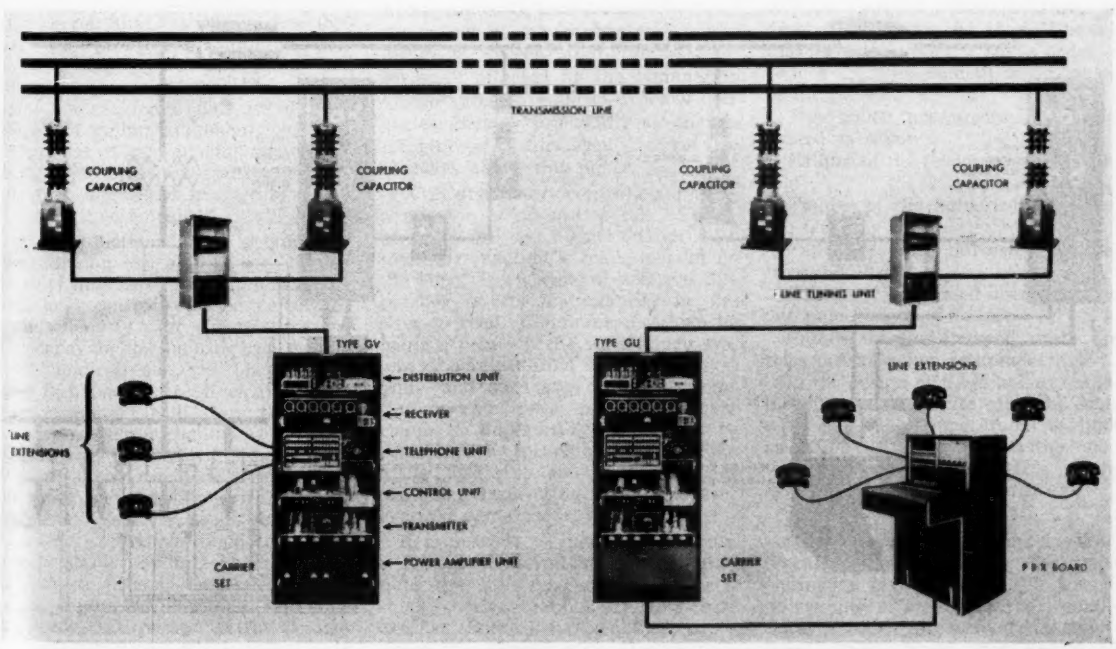


Fig. 7. Diagram of automatic simplex communication system showing connection to private branch exchange switchboard

ferred tripping. Transformer banks at the ends of high-voltage transmission lines are sometimes not provided with circuit breakers on the high-tension or line side. Such transformer banks usually have sensitive differential relay protection, which will detect the presence of an internal transformer fault too light to cause line relays to operate. The differential relays trip the low-tension breakers directly and can be used to start transmission of a carrier signal to the high-voltage breaker at the opposite end of the line. Reception of the signal at that end causes the breaker to open, isolating the transformer bank on both sides. Such remote or transferred tripping usually uses the carrier transmitter and receiver installed for line protection. The remote tripping function is performed by modulating the carrier with audio tones, which are received on tone receivers at the other end of the line.

Telemetering and Load Control by Power-Line Carrier

Telemetering is the indicating or recording of a quantity at a location remote from the point at which the quantity exists. In power systems the quantity most often telemetered is kilowatts, but it is possible by telemetering to obtain a remote indication and record of many other quantities such as voltage, reactive power, hot-spot temperature, and tap-changer position.

With telemetering by power-line carrier, all quantities necessary for efficient system operation can be continuously indicated and recorded at a dispatching office. Unit outputs, total station outputs, tie line loads, and other load quantities can be telemetered to a common point to be individually indicated and recorded, and can then be added together in any desired combination to give total system generation or load, net tie line load, and so on. These totalized quantities can be re-transmitted to other points. For example, in one type of system operation total system generation is telemetered to each station, and each variable-load station is assigned a certain proportion of the total generation above that generated by base-load stations.

With all important quantities telemetered and totalized, a system dispatcher has before him a continuous indication and record of all the load information necessary for efficient system operation. He can divide load among stations for greater efficiency, can schedule generation for greatest economy, and can maintain tie line loadings at desired values. Without telemetering, the information necessary to accomplish these functions could be obtained only by frequent telephone calls.

Telemetering over long distances on power systems can be performed most economically by power-line carrier. With carrier equipment, the load on the most remote tie line can be indicated and recorded as easily as that on a local generator. Audio tones can be used on a single carrier channel to telemeter simultaneously as many as ten separate quantities from a given location.

Load control, manual or automatic, is frequently used in conjunction with telemetering. With manual load control by power-line carrier, a dispatcher can control governor settings at remote stations as easily as the operators at those stations can control them. To raise or lower a governor setting or a station output, the dispatcher merely pushes a button or turns a control switch momentarily to the proper position.

Automatic load control equipment is available for a variety of types of interconnected system operation. With flat tie-line control equipment, perhaps the simplest type available, tie line loads can be maintained very closely. With load swings minimized, tie lines can be operated at average loads much closer to their transient or steady-state stability limits, because departures from schedules are greatly reduced.

Automatic load control equipment is available which will provide at the dispatcher's option (within the limits of interconnection agreements), flat tie-line loading, flat frequency control regardless of tie-line loads, selective frequency control, or tie-line load bias control. With selective frequency control the load swings in a given system on an interconnection are handled mainly by that system. With tie-line load bias control, each system on an interconnection automatically aids to some extent in handling all load swings, no matter where within the interconnection the load swings occur. Whatever type of operation is selected, the equipment makes a correction in governor settings approximately every two seconds to maintain it.

For all these types of load control, power-line carrier is indispensable as a link between interconnection points

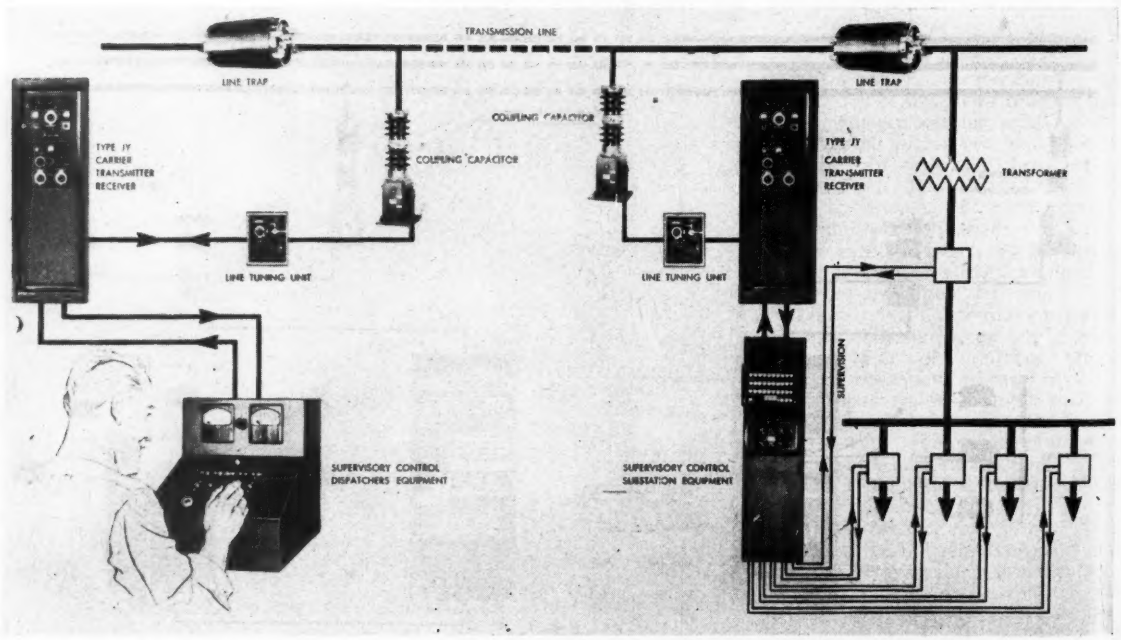


Fig. 8. Supervisory control system showing how circuit breakers at a remote station are controlled from a dispatchers office

and dispatching offices for telemetering, and between dispatching offices and remote generating stations for control.

Supervisory Control by Power-Line Carrier

Supervisory control is a system of remotely controlling and supervising from a central point the functioning of circuit breakers and other equipment on a power system. A simple power-line carrier supervisory control system is shown schematically in Fig. 8. One or a number of substations can be controlled and supervised from a central point by a single operator or load dispatcher. He can trip or close selected circuit breakers and disconnect switches, start and stop motors or synchronous condensers, switch capacitors, perform synchronizing operations, and in fact, operate entire substations from a central point. The position of all apparatus under control is continuously supervised. For example, if a breaker should trip automatically, the operator is immediately notified of the fact by an audible alarm and the lighting of a lamp associated with that particular breaker on his control panel. In one well-known system, both control and supervision are accomplished over a single communication channel, either a pair of wires or a power-line carrier channel, which interconnects the controlling point and all groups of equipment to be controlled. If the stations to be controlled are in remote or isolated locations, a carrier channel is often the only economical answer to the problem of providing a supervisory circuit.

Combined Functions on a Carrier Channel

Many of the functions of power-line carrier that have been described can be performed simultaneously over a single carrier channel, and often two carrier channels on the same line can make joint use of couplings and tuning equipment. Such efficient use of carrier equipment often justifies an investment in the apparatus that might not be justifiable for a single function alone.

Many functions which require the transmission of intelligence in the form of impulses such as telemetering and load control, can be performed simultaneously over a single carrier-frequency by modulating the carrier with audio-frequency tones. Each tone frequency is in effect a separate carrier channel itself, using the radio-frequency carrier channel as its "conductor." At the receiving end of such a channel, separate tone receivers are operated from the output of the radio-frequency receiver, each individual tone receiver being tuned to receive one particular audio tone and reject the others. One of the great advantages of tone modulation is that tone receivers incorporate extremely selective wave filters which accept only the desired tone frequency and reject the maximum amount of noise and unwanted signals. This makes it possible to operate through noise and interference which would be too severe for operation with unmodulated carrier equipment or with less selective tone equipment.

Tone equipment is available for ten carefully selected audio frequencies. Any combination of these ten frequencies may be used simultaneously on a single carrier channel. Thus, ten separate quantities may be telemetered simultaneously from a given point with a single carrier transmitter. A single carrier transmitter at a dispatching office can be used to transmit several totalized station quantities to a number of stations plus individual "raise" and "lower" impulses for control of each station.

Most carrier relaying systems require use of the carrier channel only during the presence of a fault condition. The channel is thus left free for other uses at practically all times, the only requirement being that the relays automatically take over control of the carrier channel during faults. Under normal conditions, the unmodulated carrier can be keyed directly by impulse telemetering equipment, and if it is permissible to interrupt the telemetering function at times, "push-to-talk" telephone communication can be obtained by adding a telephone handset and a simple modulator unit at each end.

If continuous telemetering and simultaneous communication are desired, audio tones below 500-cycles can be used for as many as four simultaneous telemetering functions, the audio frequencies above 500-cycles being used for speech. A filter is used to eliminate the tone frequencies from the speech at the sending and receiving ends. Speech intelligibility is not seriously affected by the elimination of the speech frequencies below 500-cycles, because practically all the intelligibility is furnished by the frequencies above this figure.

With supervisory control equipment, a number of quantities can be telemetered one at a time. Each telemetering function is made a point on the supervisory system, and the dispatcher selects the quantity he desires to read. Communication can be made a point on the supervisory system of single-station supervisory systems, and such supervisory systems can operate over relaying carrier channels. Supervisory control can be performed by means of an audio tone while several telemetered quantities are being transmitted simultaneously over the same channel.

It is possible to mention here only a few of the combinations of functions that can be performed over a single carrier channel. In an actual case, of course, the combination selected will depend upon the requirements of the particular application.

Topping at Hell Gate

(Continued from page 75)

ate a single, venturi globe regulating valve on each boiler.

A water tender's platform is located at the west end of the center aisle at El. 98 ft-6 in. Water level is transmitted optically to this platform, as well as by remote indicator to the control room. In case of emergency, the water tender can take control and maintain drum level by local manual control.

Also located at the west end of the center aisle on El. 88 ft-6 in. is an emergency control station from which the temperature of the steam may be maintained through local manual operation of valves in the water lines to the attemperator sprays.

Alarms for water level and high and low steam temperature sound simultaneously on these platforms and in the control room.

Three Proportioneer duplex pumps are used for chemical feed. They are driven by variable-speed d-c motors, remotely controlled from the chemist's table. One pump delivers sodium hydroxide to the deaerator outlet, while the other two pumps deliver disodium phosphate to the boiler drums.

Two more pumps, actuated by Treet - O - Control, deliver disodium phosphate to the City water and bearing cooling water returns in proportion to the make-up requirements. All make-up is deaerated in Condensers 2, 3, and 4 and is used for low-pressure boilers. Condensers 5, 6, 7 and 8 return condensate to the high-pressure boilers.

It is contemplated that the boilers will be emptied under pressure. In emptying, compressed air will be admitted to the upper drum in order to reduce the time element of this phase of the outage.

The boiler accessories are interlocked as follows:

Failure of the feeder trips out nothing.

Failure of the pulverizer trips out the feeder.

Failure of the pulverizer blower trips out feeder.

Failure of the forced draft fan trips out pulverizer and feeder.

Failure of the induced draft fan trips out all other equipment.

In the design of these boilers, capable of burning a wide range of coals with ash fluid temperatures as high as 2850 F, it is felt that another step toward building trouble-free, high-availability units has been made.

"Old loud mouth," a loud speaker, recently demonstrated by electronics engineers transmitts speech for 18 miles under ideal weather conditions, 3 miles under average conditions. It can be plugged into a 110 or 220 a-c power supply.

Burning Waste Wood in Suspension without Grates or Dutch Ovens

A description of three boiler installations designed to burn good waste in suspension without the use of grates or the conventional dutch ovens. Such installations permit the use of three fuels, sawdust or woodwaste, pulverized coal or fuel oil, separately or in any combination desired. One of these plants burns bark with 50 to 60 per cent water content under a small steam boiler

By John Phillips Badenhausen **Philadelphia, Pa.**

THE DIFFICULTY of burning sawdust and wood waste efficiently when used with other fuel, such as coal or oil had not heretofore been solved. The customary way of burning wood waste has been to use cast iron grates and dutch ovens.

The fuel is usually fed in through a hole or holes in the oven top, and it is difficult to control fuel and air supply so as to produce a high CO_2.

If grates are used, pulverized coal fuel, or sawdust or fuel oil cannot be burned above the grates unless these are covered with brick or coal ashes.

In 1930 the writer designed and built a sawdust and wood waste, and oil firing and pulverized coal firing combination for the H. H. Sheip Mfg. Co. of Philadelphia.

The space available for the boiler unit was 11 ft wide and 18 ft deep and a height of 40 ft.

The specifications called for the following:

Maximum amount of steam per hour —40,000 lb
Psi—160
No grates
Three fuels to be used separately or in any desirable combination
Fuels—1. Sawdust and wood waste
2. Pulverized bituminous coal
3. Bunker C fuel oil

The installation at Sheip Co., as shown in Fig. 1, consists of a 220 hp, 4-drum Badenhausen boiler, equipped with water walls and an airheater to produce air for combustion at 350 F. The boiler installation has a furnace width of about 7 ft, the whole boiler being only 9 ft wide. This 220 hp boiler and water walls has produced and is producing 1200 to 1400 hp or the equivalent of 40,000 to 46,000 lbs of steam per hr.

No cast iron grates are used in this installation, but provision has been made so that large pieces of wood can be introduced into the furnace and auxiliary air admitted to burn up this fuel.

Since this was an original idea, the writer had to invent a burner for the wood fuel which burner consisted of seven 3¼ in. tubes leading into the furnace and which permitted the wood to be blown into the furnace.

Adjustable air inlets were provided at each burner tube and the installation operated with oil or coal at an average of 14 per cent CO_2.

The wood waste comes in from a large cyclone collector. From this cyclone collector the wood waste travels down to a Servitor, designed and built by the writer, which consists of a rotary table having a fuel measuring device and a fan made of heavy steel plate and steel angles which has an air adjustment so that measured quantities of air and fuel can be delivered to the furnace in conjunction with other fuels such as pulverized coal and oil, producing high CO_2 in the furnace leading to high operating efficiency.

When this unit, consisting of a 220 hp boiler, plus water walls, plus airheater operates, delivering 40,000 lb of steam per hour at 150 lb working pressure with 14 per cent CO_2 in the furnace, the gases leave to the stack at about 360 F.

The experience which the writer had with this installation led to the second installation at the North Carolina Pulp Co., at Plymouth, N. C., in 1937, shown in Fig. 2.

In making wood pulp it is necessary to remove the bark from the pulp logs. This operation is performed in the barking drums. Approximately

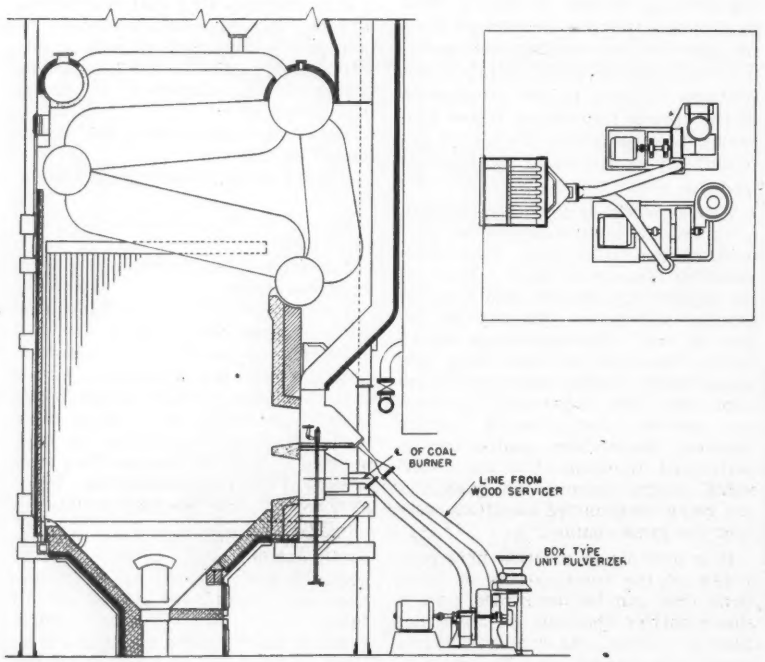


Fig. 1. The wood burning arrangement at the Sheip Mfg. Co.

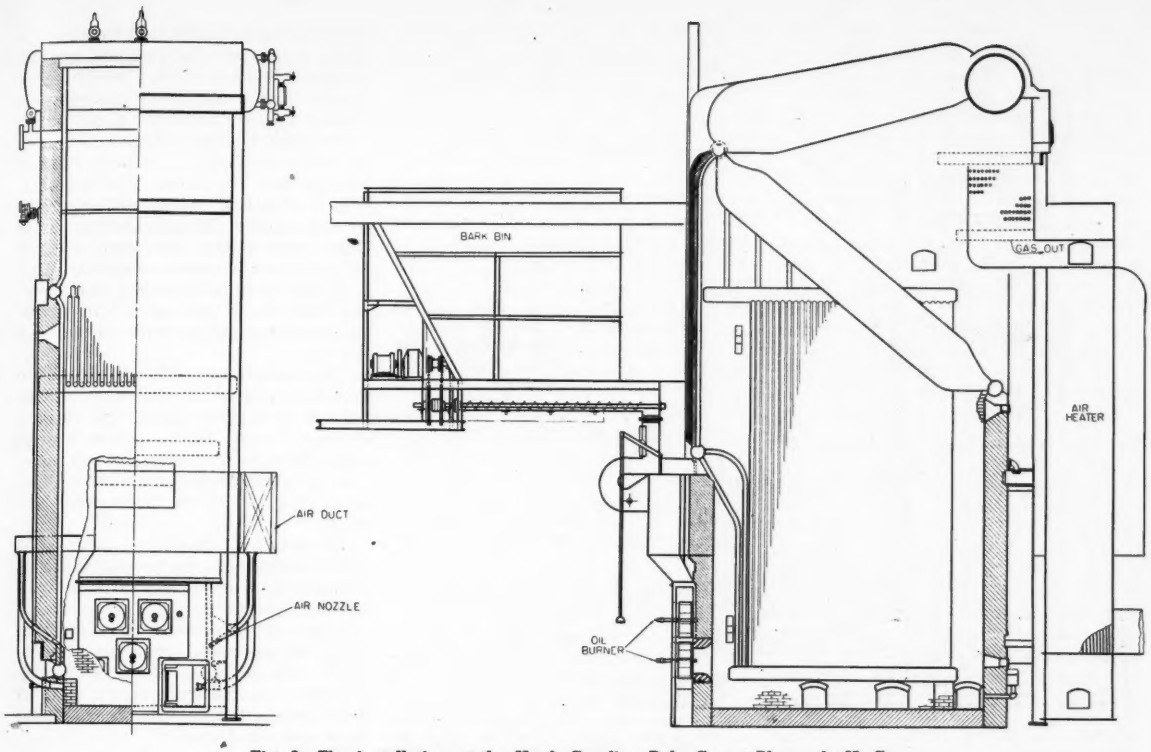


Fig. 2. The installation at the North Carolina Pulp Co. at Plymouth, N. C.

700 to 1000 cords are debarked and this waste matter must be burned as quickly as delivered to the boiler, otherwise the whole countryside will be covered with this matter.

This bark, as delivered to the wood bark burning boiler has a water content of from 50 to 60 per cent.

This completely designed and built installation was at that time and still is the only successful bark burning installation using a small boiler unit, small economizer, water cooled furnace, high air preheater, absolutely no grates, and is arranged for burning sawdust and bark and oil. All bark and sawdust is burned before reaching the bottom of the furnace.

The bark is delivered to a rotary vertical dryer, using the waste gases as a drying medium.

The bark drops into a rotary shredder and is elevated to a storage bin equipped with seven measuring screws. From this measuring device the fuel drops into a burner extending across the whole front of the boiler. The measured chips are met by a stream of highly heated air and these chips projected into the furnace burn in suspension.

There are no grates in this furnace. The width of the furnace is about 10 ft by 16 ft deep. It is water cooled and has a depth of 16 ft. The distance from the burner to the bottom of the floor is about 16 ft.

The steam generator consists of a boiler having 2600 sq ft, economizer having 700 sq ft, airheater having 7500 sq ft. Preheated air enters the furnace at a temperature of about 550 F.

This bark waste burning boiler has been operating since 1937 and with the wood and oil gives 60,000 lb of steam per hr at 700 lb pressure and 150 deg superheat. With the wood fuel alone this boiler produces 40,000 lb of steam per hr.

When it is remembered that the fuel fed has a moisture content of between 50 to 60 per cent and when it is remembered that this fuel practically burns before it hits the floor,

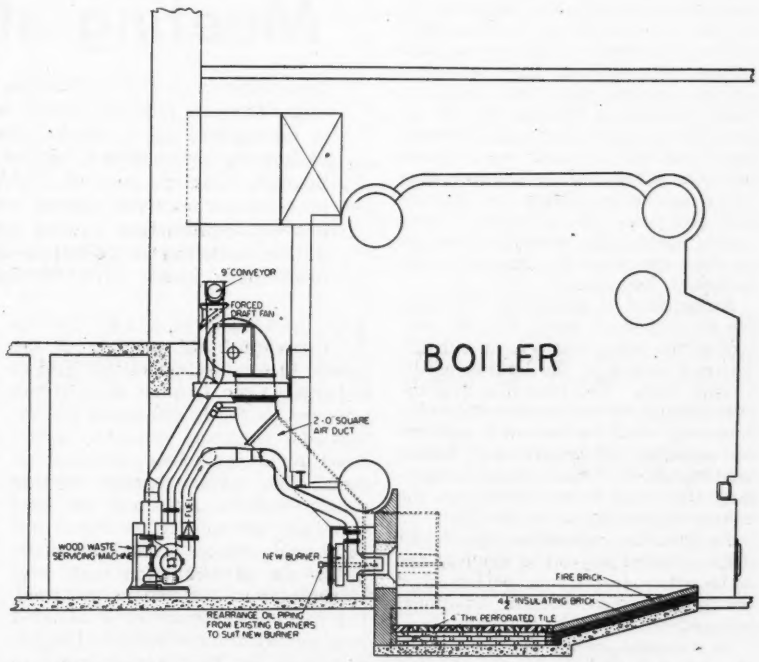


Fig. 3. Elevation of the installation at the Marine Depot of Supplies at Philadelphia

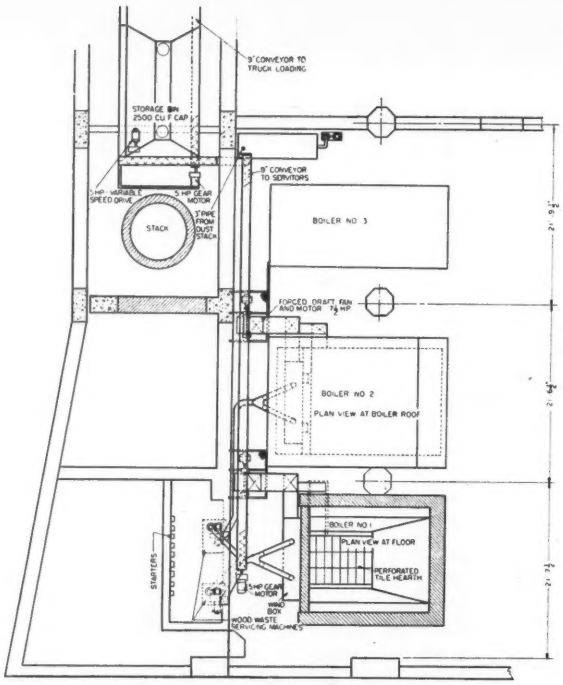


Fig. 4. Plan of the boiler room at the Marine Depot of Supplies

it shows a great advance over the old fashioned method of burning this material on grates and dutch ovens.

We now come to the third installation, Fig. 3, which was designed to burn sawdust, but also has burned satisfactorily wood chips and oil. The installation consists of a system using standard collectors discharging into a storage bin containing 2600 cu ft. This bin has on the bottom seven feeder screws practically covering the bottom of this storage bin. The seven screws discharge into one screw and the whole system is controlled by means of a variable speed device, permitting changing quantities of material delivered to the horizontal screws feeding the two Servitors. Each Servitor is for the use of one boiler and delivers the wood waste to two Peabody oil and wood waste burners, redesigned to accommodate the wood waste. These oil burners are also used in conjunction with forced draft. The control of the air to the furnace to the burners is by means of dampers.

Adjustment is made for CO_2 both for oil and wood waste but the control of the wood waste is an entirely separate device at the bottom of the storage tank. The reason is that the system must be kept in operation continuously until the system is emptied by expelling all wood waste before shutting down. This is done by stopping the wood waste flowing to the conveyors leading to the Servitor.

In practical operation the boiler does not need any oil to keep up the combustion and for a period of 8 hours has without burning additional oil produced 96,000 lb of steam.

In the summertime the demand for steam is low and the supply of wood waste is very high. The fuel value as fired is about 4500 Btu. The installation consists of two Badenhausen boilers 27 years old, which were later on equipped with water walls and are now changed over to burn wood and oil in combination or separately.

In order to preclude the possibility of throwing out unburned carbon particles the writer has designed and installed a cinder catcher which eliminates any chances of having such carbon thrown about the premises.

The installation is operated by one man who controls the amount of wood coming into the furnace at the variable feed screw at the bottom of the storage tank. If possible the wood fed is kept at the same and variation in the steam is taken care of by oil.

It should be understood that burning sawdust is one of the most difficult things to do with or without grates.

This installation, like the other two has no grates, but air may be admitted at the bottom of the furnace in case larger pieces come through and will burn in suspension. Some of the pieces coming through have been 6 in. long and ½ in. thick and ½ in. wide.

Should only sawdust be used, then this installation can be made just as efficient and as elastic as oil or pulverized coal fired.

There are therefore three installations in successful operation, one in 1931 with dry fuel, one in 1937 with 50 per cent moisture bark, and the last installation in 1944-45 with sawdust and wood waste.

The great advance in using waste fuel has not received the recognition it deserves, as it saves fuel, installation costs and great reduction in operation and repairs. Only one operator is necessary to properly feed fuel.

Smoke Prevention Ass'n Meeting at Columbus

Three-day conference, October 16-18, brings to light problems and solutions learned under war conditions—District heating is recognized as a smoke abating measure—Prepared coal makes for convenience, higher efficiency and smokeless combustion—Continuance of SFAW program favored—Gas turbine for locomotives offered as smoke abating means—Overfire air, combustion control and cinder collection offered as aids in reducing air pollution—Strong plea for operating smoke ordinances under civil service rules made by Association

DESIGNATED as a Fall Interim Conference, the meeting of the Smoke Prevention Association held in Columbus, Ohio, October 16 to 18 was attended by nearly 200 smoke inspectors and engineers especially interested in the smokeless combusion of fuels. The regular annual meeting usually held in June was not held this year due to war conditions but so many advances have been made in the art of combusion that, with transportation restrictions removed, the executive committee considered an assembly of those interested highly desirable, and the interest shown in the papers presented thoroughly justified this three day meeting.

War conditions have unquestionably delayed progress in the purification of city atmosphere and in many cases the conditions have grown worse rather than better. With war hostilities over, civic organizations are again vigorously demanding relief from smoke, fly ash, cinders and objectionable gases that too frequently pollute city atmosphere. Activity along this line is evidenced in a number of cities by plans for drastic changes in smoke ordinances, some of those proposed would go so far as to bar the use of bituminous coal.

Among the answers to complaints against smoke was one which came from Robert L. Fitzgerald of the Duluth Steam Corp. in his paper on the subject "District Heating: Post-war Smoke Solution." It is his contention that the public generally wants relief not only from smoky atmosphere but from the care of any type of heating plant. Choice of the type of heating is made by most users on a comparison of costs of installation and operation. Electric heating is thought by many to be the ideal so far as convenience and cleanliness are concerned, its cost of operation rules it out of consideration except in a very few locations where cheap power is available and the heating season short.

District steam heating that comes to the residence or apartment building just as other utilities do is also a favorite choice but is not now available except in closely built up areas, or planned housing districts. This type of heating would come from plants large enough to employ skilled firemen who, with proper combustion equipment, could operate the plant without producing smoke.

Among the fuel burning heating plants the most common are those using gas, oil and coal—named in the order of their convenience. From an economic standpoint, coal is favored and is by far the most commonly used for comfort heating purposes. While coal is most objectionable because of its inconvenience and smoke nuisance, many improvements have been and are still being made to overcome its objectionable features. With proper equipment nearly all types of coal can now be burned, even in small plants, without smoke.

Flash Pulverization of Coal

Among the more recent developments in the preparation of coal, principally for industrial use, is a new method of pulverizing coal which was described by Dr. A. D. Singh of Illinois Institute of Technology. This method is known as flash pulverization by means of either steam or compressed air. The principle is that of passing either crushed coal or coke breeze which has been satuated with steam or compressed air through a nozzle thus allowing the rapid expansion of the fluid to shatter the particles of the fuel into fine powder which is readily burned in a properly designed furnace.

Stokers and stoves are being improved so as to secure smokeless combusion with various types of coal and other fuels. Smokeless fuels are being developed from high volatile coals, these include manufactured gas, liquid fuel and coke. Sour natural gas is being treated to remove its objectionable features and yield a sulphur by-product which will at least help to defray the expense of the process.

Engineers have long recognized that complete combustion is smokeless combustion and as such it can be made to yield more useful heat than when carbon particles are permitted to be emitted with the gaseous products of combustion. During the war conservation of fuel has been a national necessity and to aid in this conservation the U. S. Bureau of Mines set up a program of education that involved every user of fuel from the smallest householder to the operators of immense industries. John Barkley of the Bureau outlined the work that had been carried out largely through the Solid Fuels for War Administration and several thousand volunteer workers throughout the country. One of the greatest contributions of this program for conservation was the publication of what are known as quiz sheets which cover all conceivable types of fuel using equipment and indicate features of operation and construction that are likely to cause loss of heat or power.

Progress Being Made in Elimination of Locomotive Smoke

Much of the program at the meeting was devoted to the problems encountered by the railroads in preventing smoke from their locomotives. In their search for the solution of the smoke problem furnaces have been studied as to methods of introducing air through the grates while the locomotive was standing still at stations as well as traveling at various speeds, and there was a demonstration at the railroad station in Columbus of four different methods of introducing air over the fuel bed in locomotive fire boxes to produce turbulence as an aid to combustion and smoke elimination. Complete satisfaction has not been attained but research is being continued and progress is reported.

As one of the suggested means of preventing locomotive smoke, Dr. John I. Yellott of Bituminous Coal Research, Inc., described the locomotive gas turbine and assured his audience that practical application is on its way in this country. The first units will use oil as fuel but with the development of flash pulverization, coal in pulverized form will be tried out as economy of operation favors the use of coal in comparison with oil.

Weather and climatic conditions have more to do with the smoke pall that hangs over cities than most of us are likely to realize and little can be done to relieve that situation except not to make smoke or discharge fly ash into the atmosphere. Dr. C. Dillon Smith, Senior Meteorologist of the U. S. Weather Bureau, however, pointed out a number of ways in which to alleviate conditions. One of the worst offenders is the plant that makes smoke in the hours from midnight to dawn, this would include also the practice of blowing soot during these hours, also carelessness in breaking up banked fires or building fresh ones.

The earth's surface is coolest at early dawn and, with slight variation in specific gravity between air near the ground and that at higher strata, the force necessary to carry the smoke and dust particles to higher levels where they can be dissipated by air currents is lacking. Also dust particles are conducive to moisture precipitation that is quite prevalent around dawn and frequently result in the characteristic smog that bedevils city dwellers particularly in winter time. City planners, Dr. Smith suggests, would do well to study the direction of prevailing winter winds and work to have industrial plants and potential smoke makers locate to the leeward side of the city's residential and business areas.

Various methods and equipment for collection and disposing of chimney dust were discussed in a symposium on the subject following a paper by Robert Blessing of the Research Corp. Means commonly used include washing or spraying, filtering, cinder catching fans, cyclones and electrostatic devices. The need for dust specifications that can be used practically in the writing and enforcement of smoke ordinances was emphatically pointed out by many in the audience.

In a discussion of combustion control equipment as a means of abating smoke, M. W. Crew of Perfex Corp. strongly recommended modulated systems for stokers since by graduated adjustments the combustion conditions do not undergo violent changes that are conducive to inefficiency and smoke making. In the burning of oil, he considers the use of excessive furnace air, the main trouble in the securing of proper combustion.

Tribute was paid by W. D. Langtry of Commercial Testing and Engineering Co. to the coal industry for maintaining, during the strenuous war conditions, a relatively high quality of coal. While not as good on the average as during peace time many of the lower grade mines had to be worked and the availability of modern mining machinery was limited, the combustion equipment in most plants, however, was able to use the fuel delivered with reasonably efficient results. He was speaking on the subject of the application and interpretation of coal analysis and stated that in general practice coal with no more than 22 to 26 per cent volatile constituents is considered smokeless.

At the closing session of the meeting the Association adopted a resolution demanding that municipal smoke inspectors be hired under strict civil service examination for the reason that it is almost impossible for cities to obtain competent smoke inspectors through political appointment, and in many cases no inspector at all because political appointment does not guarantee proper salary or a lasting job for combustion engineers.

Sixth Water Conference

Civil section of Engineers' Society of Western Pennsylvania conducted conference in Hotel William Penn, October 22 and 23 . . . Reports on recent investigations of boiler waters . . . Corrosion problems studied . . . Industrial water requirements . . . Water softening by electrolytic method . . . Ion exchange principles of water treatment

FOR THE SIXTH time the Engineers' society of Western Pennsylvania held a two-day conference, October 22 and 23, on water treatment problems as encountered in industries and municipalities. These conferences are an activity of the civil engineering section of the Society and are carried through by the water conference committee consisting of H. M. Olson, chairman, Max Hecht, R. D. Hoak, E. P. Portridge, D. S. McKinney and S. F. Whirl. Each year the attendance has increased as the value to industry of the information brought out at the meetings has been recognized. This year there were 380 registered attendants who came from all sections of the country and for the most part are chemists confronted with water treatment problems but many who attended are engineers interested in the application of water treatment for some specific industrial purpose.

Boiler Water

Boiler scale formation at elevated pressures has for a number of years been under laboratory investigation by J. A. Holmes of the National Aluminate Corp. Two years ago he reported his findings with pressures of 800 psi. His most recent experiments have been conducted on boiler waters at 1500 psi in a new type of laboratory boiler and his report was to a large extent presented pictorially.

Conclusions drawn from tests that he has made are that magnesium in the presence of phosphate under certain conditions causes deposits. More organic is needed to condition sludge as the boiler pressure and magnesium content of the feedwater increases. Silica can be reduced internally in the boiler water by the addition of magnesium but excess phosphates hinders this reaction.

In his paper on the collection and evaluation of data, V. V. Kendall of the National Tube Co. stressed the need for accuracy in the collection of original data. Much of our published engineering data is based on original investigations carried on many years ago under conditions and with instruments that would not be acceptable in research work of today yet formulas and curves based on these early experiments are still being used in practice. When using reported data in scientific work, the investigator should know the details of how these data were collected and should determine their accuracy for the purpose desired. The analysis of one or two samples, he declared, is not enough, four to five specimens is preferred practice. Much time and money can be saved if when an investigation is carried out arrangements are made to obtain and record complete data on all conditions surrounding the experiment for in many instances the data collected may have uses unforeseen at the time the experiment is made.

Some of the technicalities surrounding the behavior of highly concentrated boiler water were discussed by C. E. Kaufman, V. M. Marcy and W. H. Trautman, all of the Hall Laboratories, Inc.

It was stated that dilute boiler water is well-known, but the development and the properties of complex concentrated boiler waters in certain portions of high-pressure, high-capacity boilers have been little understood. Such localized concentration of boiler water can promote hideout of soluble salts, scale formation, and attack by bonded oxygen.

Corrosion by bonded oxygen, the oxygen chemically combined in water, is increased as the free alkali content of the concentrating film boiler water is increased. This attack may result in grooving, wastage, and sometimes in the degeneration of metal at the inside surfaces of a tube. Such degeneration is characterized by loss of carbon from the steel and the development of the intergranular damage, rendering the metal quite brittle.

The manner in which boiler water concentrates locally at a heat-transfer surface was explained on the basis of the phase rule, a generalization which permits the logical correlation of many diverse phenomena taking place in boilers. A boiler-tube section containing a plug of magnetic iron oxide is used to illustrate the development of successive layers of concentrating-film boiler water.

Experimental data were presented on vapor-pressure determination and corrosion testing, which measures respectively the extent of concentration to be expected and the aggressiveness of certain solutions representing concentrated boiler waters.

Water Treatment in German Plants

German power plant water conditioning systems were discussed in a paper by W. W. Cerna, of Hall Laboratories, Inc., who stated that in general, German water supplies may be considered as decidedly hard, both in the case of well waters and river waters. Because of the high degree of industrial development in relatively small areas, most of the rivers are quite highly contaminated with industrial waste. As a result, chemical water conditioning is a necessity and is used industrially on a decidedly large scale.

Basically, the various methods of water conditioning in use in Germany are the same as those employed in the United States. However, there are enough variations to make a number of the German water-conditioning systems of considerable interest to American engineers.

External silica-removal systems are commonly found, as it is an axiom among the German engineers that for high-pressure boiler operation, the silica content of the boiler water should not be above 7 ppm.

Silica-removal systems fall into two main classes, depending upon whether cold or hot-process units are used.

For cold-process silica removal, a combination of magnesium chloride and sodium aluminate is used as the active reagents. The plants are usually operated to obtain no more than 1 ppm of residual silica in the treated water and filtered water. In order to accomplish this, a high rate of chemical feed is required.

Hot-process systems for silica reduction are similar to the usual American practice. Dolomitic lime, lime and magnesium oxide, or caustic soda and magnesium oxide are used to produce a combination of carbonate hardness and silica reduction. At first, large amounts of magnesium oxide (200 to 400 ppm) were used to obtain residual silica concentrations of less than 1 ppm. With the shortage of chemicals which developed during the latter part of the war, particularly due to transportation difficulties, considerable success was obtained in getting good silica removal with greatly reduced chemical feed, by increasing the amount of precipitated sludge recirculation.

For high-pressure boilers, condensate feedwater systems are most commonly employed, even though process steam requirements are high. Where treated make-up water is used, final softening by either hot phosphate units or base exchange softeners are always employed.

The maintenance of internal boiler-water conditions based on phosphate treatment is universally used in the German steam power plants.

Cold Water Deaeration

With the assertion that corrosion of ferrous and non-ferrous equipment due to dissolved gases in a relatively cold liquid results in enormous losses to industry each year, Sheppard T. Powell, Consulting Chemical Engineer, Baltimore, Md., stated further that no universal corrective treatment is applicable to all problems of this nature. Cold water vacuum deaeration, however, has earned an impor-

(Continued on page 134)

Oil Circuit Breaker Demonstration Tests

New principle of arc extinction demonstrated by Roller-Smith Co.—Laboratory built for "on the line" service testing—Substation of Pennsylvania Power and Light Co. provides the necessary interrupting capacity of 250,000 kva for largest breakers—Test station facilities enumerated—Results of tests are given and oscillograms presented

DEMONSTRATION of a new line of oil circuit breakers was recently carried out before a joint technical committee of the EEI-AEIC-NEMA under rigid test conditions formulated by the Committee. The tests were conducted on equipment manufactured by Roller-Smith Co. at its "on the line" test station, and the demonstration was designed to show the operating efficiency of breakers rated at 100 mva and 150 mva interrupting capacity and employing a new "Exotherm" principle of arc extinction. The tests were supervised by Dr. A. C. Bates and Professor A. R. Miller of the Roller-Smith engineering staff.

In providing test facilities it is recognized that test conditions should duplicate as nearly as possible the conditions under which the breakers are to operate in service. Field tests on actual systems, particularly near a large concentration of power, provide most severe testing conditions. In such tests the most exacting service conditions exist with respect to; sustained voltage during the short; normal frequency recovery voltage; transient recover voltage; decrement; and stored electrostatic and magnetic energy.

To accomplish best results, the problem resolves itself into that of designing a field testing station with the flexibility of a laboratory and one that would not interfere with operation of the utility from which the power would be taken.

Location of Test Station

Fortunately the location of the Roller-Smith Co. plant is such that a testing station of this type could readily be built. The Pennsylvania Power and Light Co. Siegfried Substation, one of the largest in the world, has two 220 kv incoming lines which interconnect this substation with other power companies. In addition several 66 kv lines from other Pennsylvania Power and Light Co. generating stations bring power to this central point. Altogether there is a short circuit capacity of approximately 1,250,000 kva at this site. Only a portion of this capacity is required for testing breakers manufactured by this company, the largest of which has an interrupting capacity of 250,000 kva.

The test station built by the company is located about 900 ft from the Siegfried substation and is comprised of a test building, control house, together with transformers, reactors and other apparatus which constitute a most complete laboratory for testing the entire line of air and oil circuit breakers manufactured by the company.

The test station is designed to limit the short circuit to 250,000 kva or 20 per cent of the short circuit capacity available. The disconnecting switches, transformers and backup breakers being a part of the testing station, none of the power companies major equipment is stressed beyond its rated continuous capacity. In addition, the service imposed upon the system by this arrangement results in minimum voltage disturbance. It does not interfere with service to power customers because the metal clad switchgear backup breakers are set up to operate before such disturbance can occur.

In the design of the station, are disconnecting switches, special transformers, backup breakers, reactors and oscillograph recording equipment.

There are three single phase transformers. The high side is 66 kv with five 10 per cent taps to provide voltage adjustment. The secondary winding of each transformer consists of four 2250 v windings which may be connected in series or parallel. In addition, the transformers may be connected in either Delta or Wye. Full capacity 3 phase tests can therefore be made at the following voltages:

Delta Connected	*Wye Connected*
2250	3900
4500	7800
9000	15600

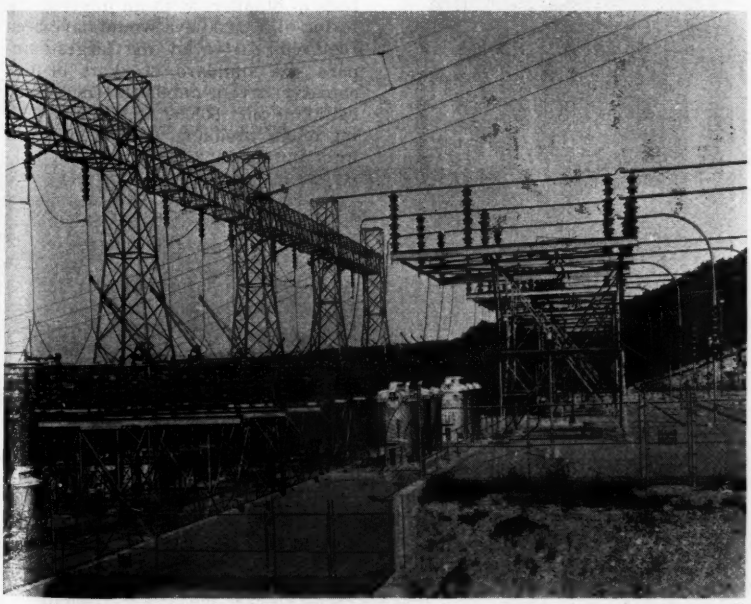


Fig. 1. Siegfried substation of Pennsylvania Power and Light Co. with over 1,250,000 kva short circuit capacity to which Roller-Smith test station is connected

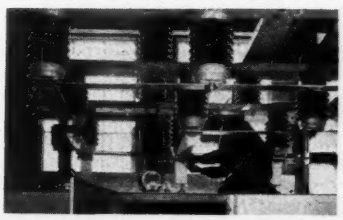


Fig. 2. Test station backup breaker. One three-pole 1200 amp 250,000 kva breaker is used for each phase resulting in a three phase interrupting capacity of 500,000 kva

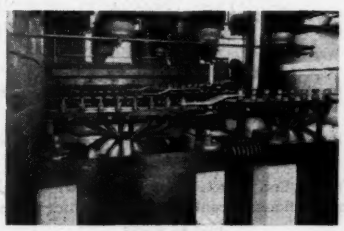
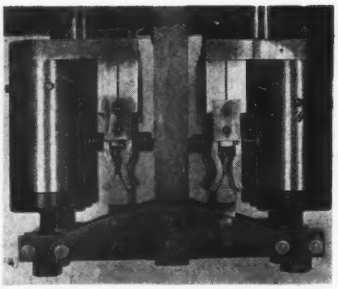
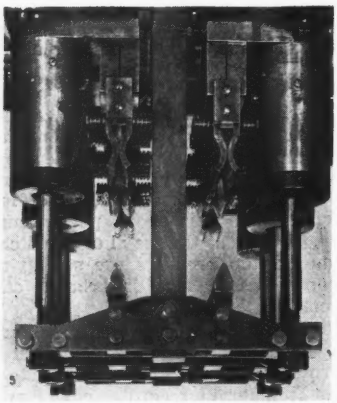
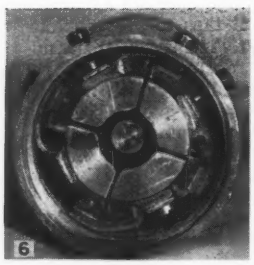
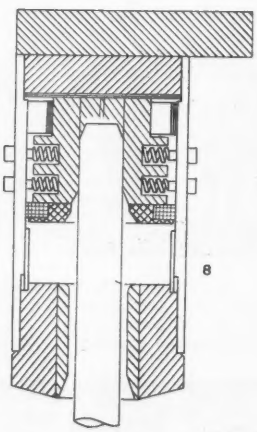


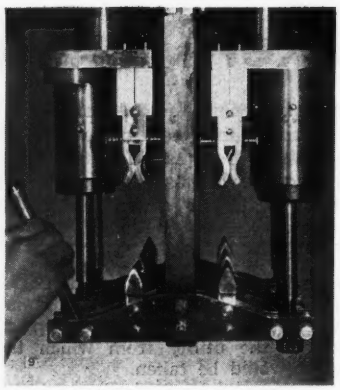
Fig. 3. Top changing on the current limiting reactors

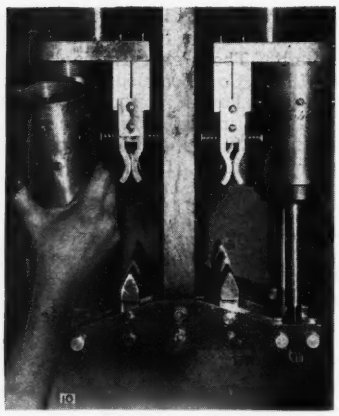












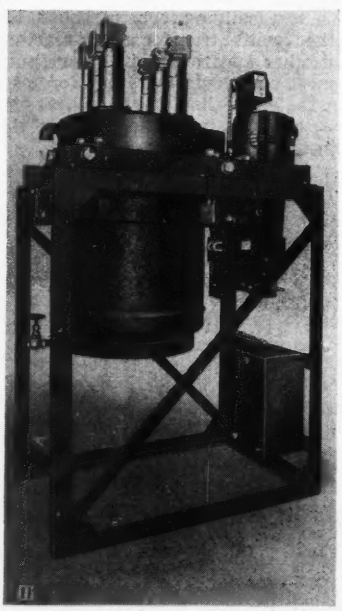


Fig. 4. Explosion pots for Exotherm arc extinction with contacts closed

Fig. 5. Explosion pots with breaker open showing main auxiliary contacts

Fig. 6. End of explosion pot showing wiping stationary contacts with auxiliary contact in place

Fig. 7. Auxiliary contact after two test shots —130,000 kva, 7500 v without any dressing

Fig. 8. Cutaway view of explosion pot

Fig. 9. Auxiliary contact being removed for inspection demonstrates ease of maintenance

Fig. 10. Explosion pot being replaced after inspection

Fig. 11. New Roller-Smith oil circuit breaker with Exotherm arc extinction rated at 150,000 kva 15000 v

By means of tap changers on the high side two 10 per cent steps above these voltages and two 10 per cent steps below these voltages can be used.

For single phase test, the primaries and secondaries of the transformers, may be paralleled on one phase to give greatly increased capacity on the Delta voltages if such testing should be required in the future.

Each transformer is also provided with a two section tertiary winding which when connected in series gives 600 v and when connected in parallel give 300 v. These windings are especially designed and braced to give extremely high short circuit currents. The impedance of transformers is such that the short circuit current at the terminals of the windings for a 3 phase short circuit is 270,000 amp at 300 v and 135,000 amp at 600 v.

In addition, single phase tests may be made by paralleling the transformers and a current value of 450,000 amp at 300 v secured.

The reactors are especially designed for this service and consist of two reactors for each phase which provide 14 steps of impedance for testing from 25,000 kva to 250,000 kva 3 phase on the secondary winding. In addition to the bracing required to withstand the short circuits, it has been found necessary to materially increase the insulation over that usually required in testing stations so as to be able to withstand the surge voltage at the time of circuit interruption.

In order to avoid any disturbance to the power company's system or to its customers when breakers are tested to destruction, a complete metal clad backup switchgear installation was made part of the test station. To provide a margin of safety, backup breakers with an interrupting rating of 500,000 kva would have been required. However, the largest ampere size standard breakers of this capacity have a published one/second rating of only 80,000 amp. Since testing of air breakers would require an interrupting capacity of at least 100,000 amp, it was decided to use one 3 pole 1200 amp 250,000 kva breaker for each phase. This combination resulted in a 3 phase interrupting capacity of approximately 500,000 kva and gave a theoretical one/second rating of 180,000 amp, sufficient for testing the largest air breaker manufactured by the company. The backup breakers are tripped in a short definite time after the fault is applied, the fault current itself initiating the timer.

Principles of Interrupted Current

The interruption of an electrical circuit by a circuit breaker is something of a race between the ability of the breaker to establish a medium of sufficient dielectric strength between the separating contacts and a rising voltage incident to opening the circuit. Prior to the opening of the switch there flows a certain current,

such as a normal load current, a short circuit current flowing from a nearby generator, either in the field or laboratory, or the short circuit current existing in a system due to a fault, or in a testing laboratory.

Upon the interruption of the circuit this current has been removed or cancelled in the circuit. A simple way to answer the question of how the voltage behaves at the interruption is to define the amount of voltage which would be required to circulate a current which at each instant of time cancels the current being interrupted. In a way, it might be said the switch acts something like a generator, which supplies this cancellation current, producing the condition occurring at breaker operation. The original current, together with the super-imposed current brings the current to zero in the circuit, which is the condition established upon opening the switch. To find the switch voltage is to evaluate the voltage required to circulate the superimposed current.

Circuit Breaker Requirements

In order to build a circuit breaker or a switch requires a mechanism, container, insulators, and other necessarily related parts, but these parts are secondary to and for the purpose of attaining current interruption by the switch. This is mentioned for the purpose of putting these related features in their proper perspective. The heart of a circuit breaker is the arc quenching device and the current carrying contacts, usually physically separated from each other. This is true whether it be an air or an oil breaker.

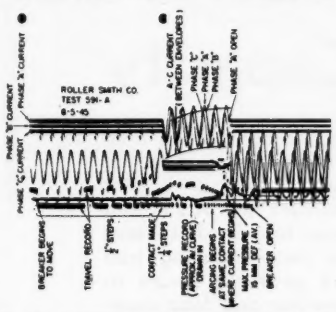


Fig. 12. Interpretation of oscillogram taken during test of Roller-Smith oil circuit breaker with Exotherm arc extinction

A knowledge of properties or characteristics of a space which will support an arc is a most necessary prerequisite. It is known that the conduction of a gas is a function of its temperature and pressure, and that these quantities are further inter-related to each other, or that one is a function of the other.

As the temperature of a gas is increased its conductivity is increased, but not in a linear fashion; also as the pressure of a gas is increased, its conductivity decreases. Any arrangement whereby the heat of an arc can be extracted tends to make the arc medium non-conducting, and thereby quench the arc.

A method has been devised whereby this can be accomplished in an oil circuit breaker. Extensive tests "on the line" at the Roller-Smith test station have demonstrated that this principle gave a practical method of arc extinction. This new principle of arc extinction has been named the Exotherm principle. It makes possible, according to the manufacturer, an entirely new approach to the problem of arc extinction.

In the arc quenching devices exhibited in the breakers tested at the recent demonstration, this cooling is accomplished by bringing the arc intimately in contact with the oil; at current zero it is intended to have these hot gases so arranged that a maximum of heat will leave them thus raising the dielectric strength to a point where the arc is quenched as the current passes through zero. At the same time, the high pressure in the quencher assists in the process.

Certain secondary effects, however, cannot be overlooked, in this process. In the first place the gases are generated in an enclosure, and upon expanding through the body of the oil in the tank are quite effectively cooled and condensed. This relieves the internal tank pressures to very nominal values. Since this volume of gas is reduced, less space is required between live parts of the breaker, internally. Moreover, the pressure further assists in accelerating the moving parts of the breaker. It increases the speed of opening, or decreases the length of time the arc is in existence, thereby decreasing the burning away of the arcing contact members.

It is a simple device which has merits from all points of view. Sometimes these effects are far reaching,—for example, lower pressures in the circuit breaker means thinner walled oil tanks,—this means better heat conduction,—which means more capacity in the same space. Higher speed of operation will necessitate more effective shock absorbers to relieve stresses in the mechanical parts, but these are not too difficult to arrange.

It goes without saying that these breakers are thoroughly tested at the testing laboratory. In the specifications are given a lower and a higher voltage rating. At these extremes and at intermediate voltages, a series of tests from low current values to the highest required current, at the given voltage, are made. Arc lengths, consistency of operation, and other factors are carefully noted. Figure 12 shows curves of speed, velocity, and acceleration drawn from a particular oscillogram. Stresses can be accurately checked, and compared to the average safe values for the material concerned. This information is obtained from the travel record on the oscillogram.

Ordinarily, for a 3 phase oil breaker eight separate oscillogram records are taken, although this might be varied sometimes. Here are shown, from top to bottom, 3 phase currents, 3 phase voltages, pressure and travel records. These various quantities, and further defining statements, are indicated on the oscillogram. One feature of operation insisted upon is that during the quenching of the arc in the various phases, the quenchers shall interrupt the phases successively in the order in which the phase currents pass through their zero values, with a grounded neutral. This requires a time lapse between successive phases corresponding to 60 electrical degrees, or to 1/360 second. Likewise, other pertinent information can be obtained.

The following data will assist in the interpretation and identification of the oscillogram taken at the time of the demonstration before the committee. These oscillogram records are the same as outlined in Fig. 12, namely, reading from top to bottom:

1. Current Phase A
2. Current Phase B
3. Current Phase C

(Continued on page 99)

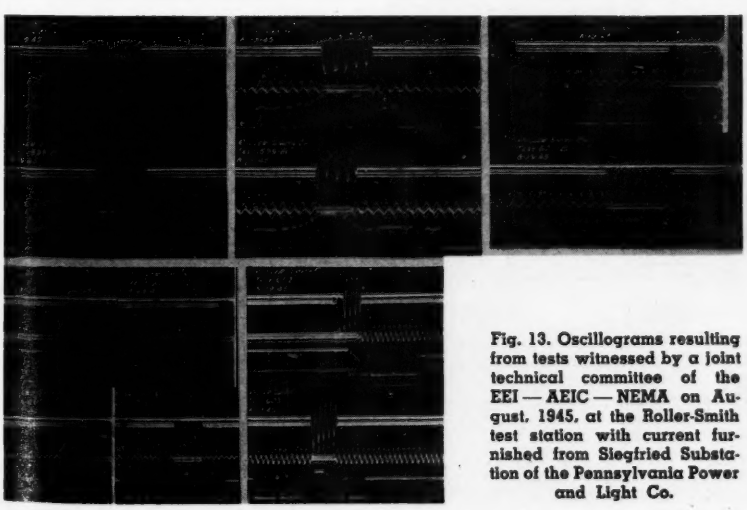
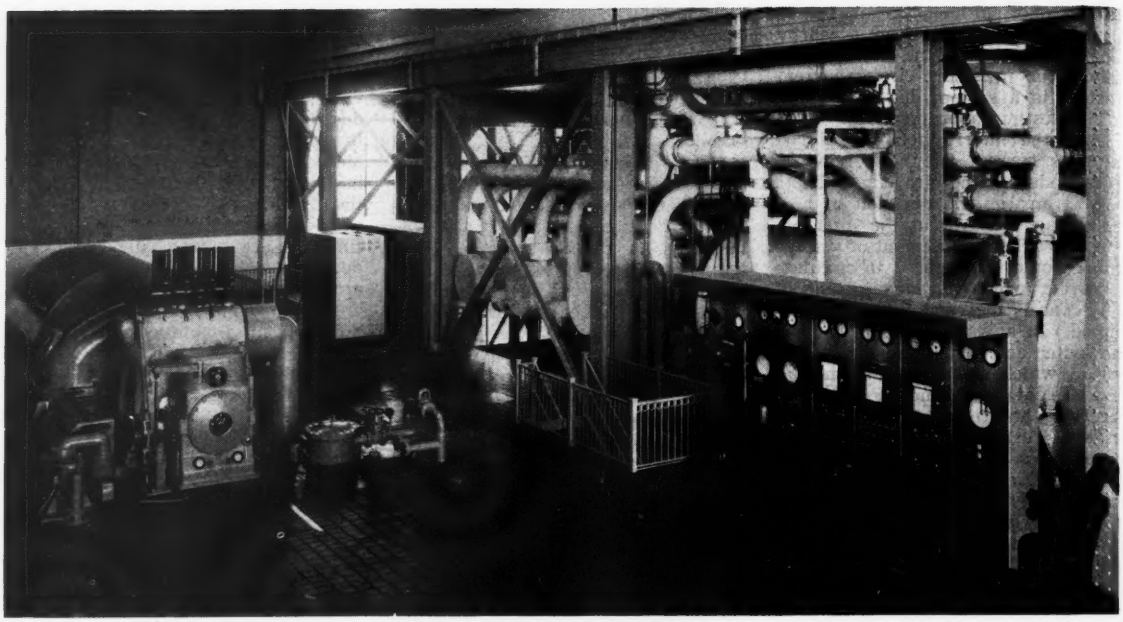


Fig. 13. Oscillograms resulting from tests witnessed by a joint technical committee of the EEI — AEIC — NEMA on August, 1945, at the Roller-Smith test station with current furnished from Siegfried Substation of the Pennsylvania Power and Light Co.

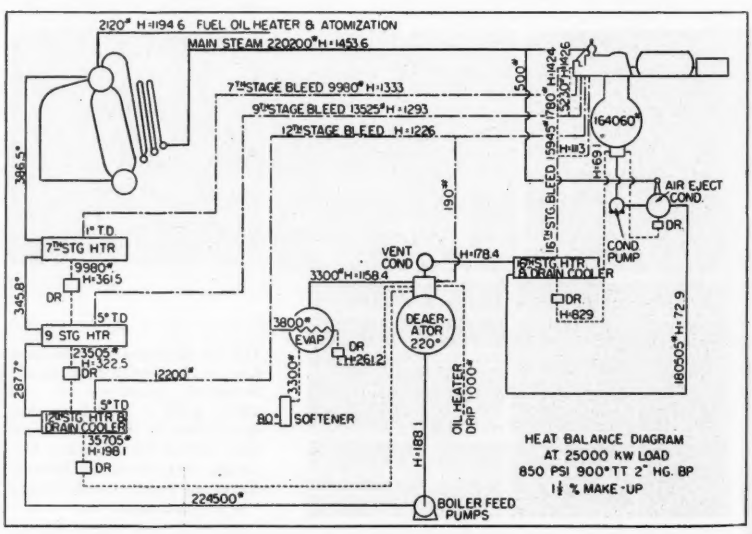


New Unit of Florida Power Corporation at Bayboro Plant in St. Petersburg Adds 25,000 kw to System Capacity

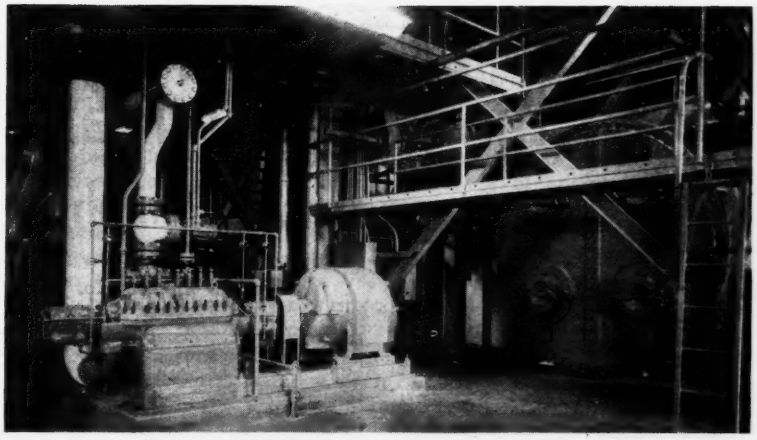
Plans delayed by WPB ruling were released in 1943, permitting completion of construction and starting of operation early in 1945—Lowest fuel costs determined choice of 850 psi F steam—Plant burns Bunker "C" fuel oil—Two integral furnace boilers are installed, each of 175,000 lb per hr capacity—Electric generator has 31,250 kva capacity and is cooled with hydrogen at ½ lb pressure—Condenser has divided water box and uses aluminum brass tubes, water velocity 6 ft per sec—Reducing and desuperheating station has capacity of 125,000 lb per hr and provides steam at 300 psi and 600 F—Boiler salines recirculated—Evaporator, deaerator and four stage heaters bring feedwater temperature to 386.5 F—All auxiliaries are electric driven

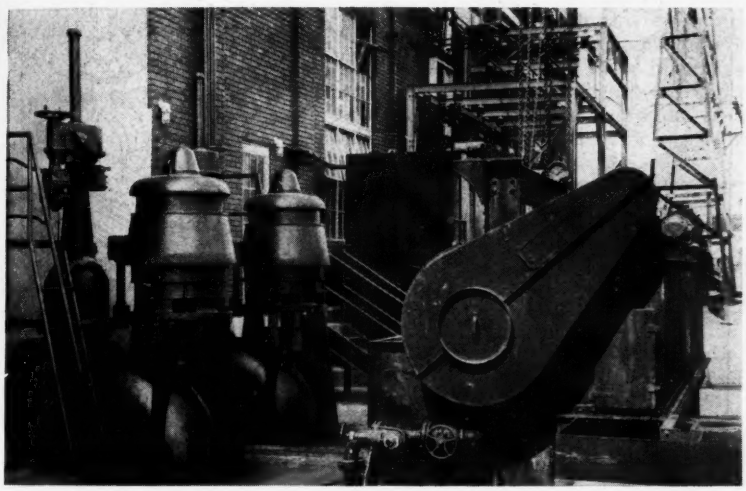
At the top of this page is a view in the turbine room of the Bayboro plant showing the new General Electric turbo-generator unit rated at 25,000 kw, 11,000 v, 3,600 rpm, taking steam at 850 psi, 900 F, exhausting at 2-in. Hg and provided with 4 stages of bleeding. The generator is hydrogen cooled and served by a direct connected, room ventilated exciter. An explosion diaphragm and a low vacuum trip are provided on the exhaust hood. A turning gear is also provided.

The heat balance diagram has been worked out for four stages of bleeding and it is expected the unit at rated capacity of 25,000 kw will meet the following performance: Turbine heat rate, 9576 Btu per kwhr; boiler efficiency 87 per cent; power used by auxiliaries 4.36 per cent; make-up loss 1.5 per cent; plant factor 98 per cent; and Btu per net kwhr, 11,777. The boilers in this unit consists of two, two-drum, integral furnace type design for generating steam at 950 psi, steaming rate 175,000 lb per hr, heating surface 13,170 sq ft each, and 6600 cu ft furnace volume—the product of Babcock & Wilcox Co.



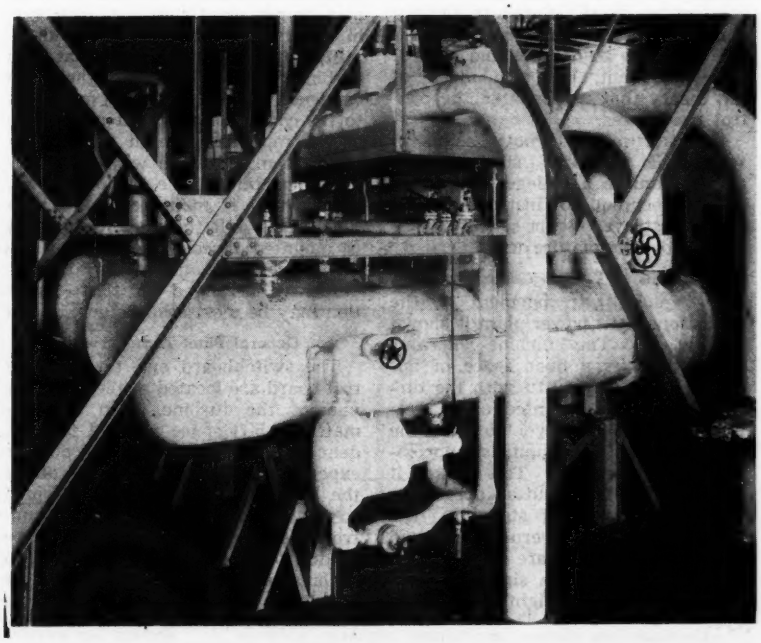
Boiler feed pumps and the outlet end of the condenser are brilliantly lighted by fluorescent units. These three pumps have a capacity of 420 gpm, designed with three stages to deliver water at 1100 psi and were furnished by Pennsylvania Pump & Compressor Co. Conditions surround the condensing system dictated a design varying somewhat from the usual. Sea water from Tampa Bay and the harbor made the use of Admiralty metal tubes unsatisfactory, so tubes of aluminum brass were decided upon after careful investigation and tube sheets are of Muntz metal. A divided water box condenser was mandatory for continuous operation because of trouble experienced with oyster shells and barnacles. The condenser, which was built by Westinghouse Electric Corp., has a steel welded shell, cast iron boxes and is single pass with 23,000 sq ft of condensing surface. The water velocity is 6 ft per sec.





Two vertical circulating pumps and the traveling screens are located outside the building wall. The decision to install two half-capacity pumps was influenced by the necessity for continuous operation and past troubles with oyster shells and barnacles. The intake well serves only the new unit and is divided into two sections each with a traveling screen and a vertical circulating pump. Provisions are made so that the intake well can be cleaned out one-half at a time without stopping generator service. These Fairbanks, Morse & Co. pumps have a capacity of 20,000 gpm each and are driven at 585 rpm by 125 hp motors. The traveling screens have baskets 8 ft wide, will pass 20,000 gpm and are the product of Chain Belt Co.

Shown here are the high pressure feedwater heaters. For the entire station, feedwater is supplied from a deaerating heater with a storage capacity of 10,000 gal which operates a constant pressure of 2 lb gage. The evaporator used to supply make-up discharges its vapor into the deaerator and receives its supply of steam for the coils from either the 9th or 12th stage extraction points. Any additional steam required by the deaerator above that being supplied by the evaporator is taken from the 12th stage extraction line through a reducing valve. Due to the low temperature of the deaerated water supplied to the boiler feed pumps, the three upper stages of feedwater heating are at full pump pressure. This necessitates the use of drainers and arrangement for cascading of the drains from the heaters into the deaerator. These heaters are of the straight tube type manufactured by Alco Products Co. •



A New Technique in
Teaching Power Plant Operation

By F. H. Pumphrey

Educational Service Division
General Electric Co.

A COMPLETE and carefully coordinated educational power plant unit is now ready for use by engineering colleges in their laboratories. All equipment including two 20-kw steam turbine generators with necessary controls, auxiliaries, switchboard, condenser, and electric load, is provided. The unit requires only a supply of steam ranging from 125 to 250 psi, and a source of circulating water for condensing purposes. The entire equipment can be placed in a floor space of approximately 10 by 15 ft.

Practicing engineers have shown considerable interest in techniques used by the Armed Forces in training men to operate complicated technical equipment in a minimum of time. Many have indicated a desire that some of these techniques might be adapted to civilian instruction.

The educational power plant unit is an outgrowth of the Navy Destroyer Escort School which was operated by the General Electric Co at Syracuse, N. Y., for the Navy and Maritime Commission. In this school, several thousand men were taught to operate the steam-electric power plant of the destroyer escorts in a training period limited to 4 weeks. In order to give this instruction, a complete destroyer escort power plant was set up in the Syracuse factory and the Navy enlisted men learned not only how to operate and control this equipment, but also much of the theory that necessitated the control procedures.

In peacetime it is not feasible to set up a full-sized steam-electric power plant in a college laboratory, but the technique of instruction used in the destroyer escort school can be used with a miniature unit.

Details of Turbine Generators

The general arrangement of the educational unit power plant is shown in Fig. 1. The turbine-generator group requires a floor space of approximately 8 by 10 ft, with the turbine generators mounted on a platform above floor level so that the center line of the unit is approximately at eye level. This makes it convenient to carry out all operations on the unit without stopping. The movement of the governor beam and such adjustments as are necessary on them are easily seen since they are on a level with or slightly above the eye.

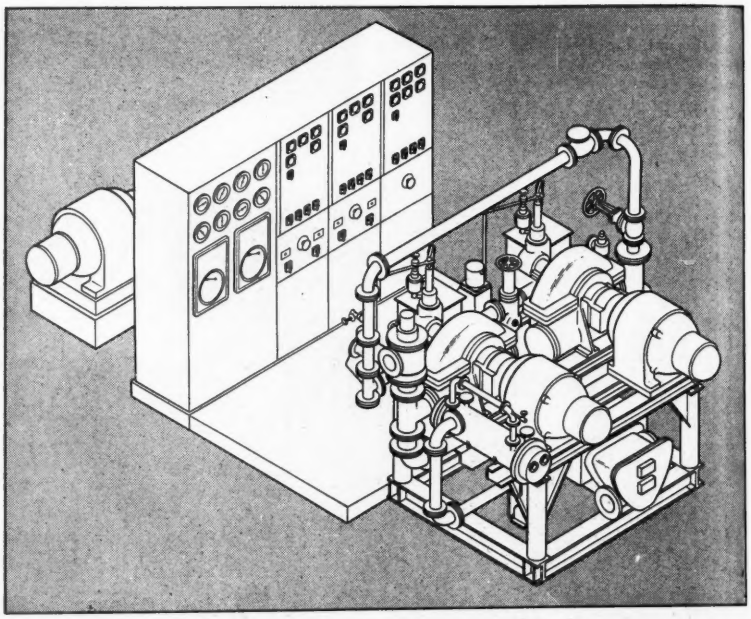


Fig. 1. Perspective view of educational type turbine-generator plant

The condenser is located directly under the turbine in accordance with best power plant practice. However, in order to obtain maximum flexibility, piping is arranged so that both turbines may exhaust into the same condenser. The use of side entrances to the condenser makes it possible to use a minimum length of exhaust piping commensurate with flexibility of connections. The steam-jet air ejector unit is mounted on the turbine level, while the condensate pump is mounted directly below the hotwell. All traps and valves are conveniently arranged so that operation may be most easily studied.

General Plant Arrangement

The switchboard and turbine control board are located at the governor end of the turbine, with approximately a 5-ft space allowed for student groups who are carrying out the experiment. A false floor 6 in. above the standard floor may be provided so that all connections to the control board and switchboard can be made from the turbine generator unit without breaking into the floor of the building. This arrangement of the switchboard permits the student to observe the functioning of the governors when the settings of the governor springs are adjusted from the switchboard.

The unusual flexibility of the unit is shown in a schematic diagram, Fig. 2. The bucket wheels of both turbines are identical so that, by closing hand valves, it is possible to give both units approximately the same nozzle area in order to operate them in parallel from the high-pressure steam main and exhaust directly into the condenser unit.

Under these conditions, it would be normal to have both units controlled by the highly sensitive oil relay, speed governor, which is standard on large-capacity turbine generators. Since the sensitivity of these governors may be adjusted, it is possible for the students to study the division of load between units with one governor considerably more sensitive than the other, and also with both governors adjusted to equal sensitivity. With this type of governor, it is also possible to make "drop load" tests to determine the turbine stability under extreme conditions of load variation.

Here are all the operating instructions, says Mr. Pumphrey, that can be given by means of this educational unit:

With the unit equipment, it is possible to teach students how to bring a turbine up to speed, place it under the control of the speed governor, make final adjustment of speed from the switchboard, and synchronize.

With the turbines in steam parallel, distribution of load between units may be controlled by the governor control switch on the generator panel. Voltage control and power factor distribution between units are controlled from exciter field rheostat on the generator panel.

For more advanced students, a study may be made of voltage-regulator operation since each generator is provided with a voltage regulator provided with load compensation so that the two machines may be operated satisfactorily in parallel. It is possible, in fact, to simulate nearly every operating situation normally met in power plant work.

Moreover, it has the advantage of providing the problem situation with miniature equipment which will not normally be damaged by incorrect operation. This is ideal from an educational point of view of course, since many lessons in power plant equipment are learned most vividly from errors.

The use of this equipment as an instruction medium in technical schools ushers in a new era in power plant instruction.

Types of Operation Possible

When it is desired to operate the two turbines in steam series, the nozzle areas may be increased by opening hand valves. One unit then acts as a high-pressure turbine and the other as a low-pressure turbine. The valve on the exhaust of the high-pressure turbine to the condenser is closed and the crossover valve is opened. With the turbines in steam series, it is possible to simulate multi-stage or cross-compound operation of the turbine, using only the speed governor of the high pressure unit. The speed governor then controls the high-pressure steam admitted to the high pressure turbines and the intermediate pressure varies with load, usually being somewhat above atmospheric pressure. This permits the students to observe the variation of load distribution between high-pressure and low-pressure stages in multi-stage and in cross-compound operation.

To simulate superposed or topping turbine operation, the frequency of the system is controlled by the speed governor of the low-pressure unit. The admission of the steam to the high-pressure unit is controlled by the exhaust pressure governor of that unit which maintains a constant intermediate pressure. With load variations, the low-pressure unit attempts to correct the inlet flow in order to maintain constant speed and this in turn reduces or increases the intermediate pressure which in turn controls the variation in inlet steam to the high-pressure unit.

Automatic Extraction Operation

Automatic extraction operation can be simulated by operating the turbine receiving high-pressure steam with control by the speed governor. The low-pressure turbine may then be controlled by the inlet pressure governor of that unit. In this type of operation when extraction steam requirements and electric load variations occur at the same time, as is typical in automatic extraction turbines, the initial pressure governor of the low-pressure turbine will admit more or less steam to maintain the desired extracting pressure while the speed governor of the high-pressure unit will admit more or less steam in order to maintain constant frequency on both units.

The problems of sequential operation between speed and pressure governors are thus presented to the students. Since only a speed or a pressure governor will be used on a single machine, excessive complication in analysis of the operation is avoided.

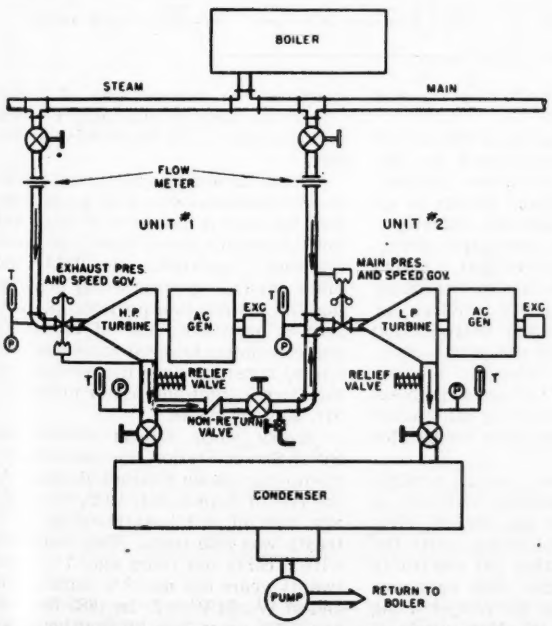


Fig. 2. **General steam diagram of educational power plant showing connections of the two 20-kw turbines, auxiliaries and controls**

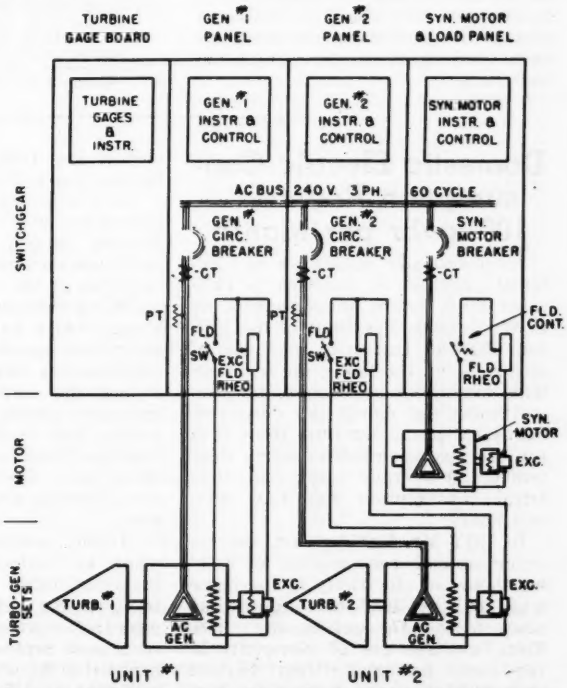


Fig. 3. **General electrical diagram of educational power plant showing generator connections, controls and auxiliaries**

Electrical Equipment

The switch and control board includes a turbine gage board equipped with a recording and indicating flowmeter for each unit and pressure and temperature indicators for both inlet and exhaust steam of each unit. In this way, it is possible for the students to get immediate data on the relationship between steam flow and power output. Principal electrical connections of the educational power plant are shown in Fig. 3.

The electric generators are 3-phase, rotating-field alternators, rated at 220 v. Each is provided with a direct-connected exciter. These alternators are controlled through modern power-station type of metal-clad switchgear using current and potential transformers to supply the instruments on the panel. Each generator panel is provided with an a-c ammeter and voltmeter with transfer switches, a polyphase wattmeter, a Var meter, field ammeters, exciter field rheostat, automatic voltage regulator, synchronizing switch, governor-motor control switch, and control for the main exciter field switch.

Figure 4 shows the arrangement of the entire switchboard including the turbine gage board, the generator panels and the load control panels.

The load is provided by a 50-hp, 3-phase, synchronous motor driving a water brake. Using this load, it is possible to vary both the magnitude and power factor of the load on the generators. The magnitude of the load is controlled by an adjustment of the level of water in the brake. The power factor is, of course, controlled from the load control panel on the switchboard by adjustment of the exciter field rheostat. This arrangement gives complete flexibility as to load conditions throughout the load range.

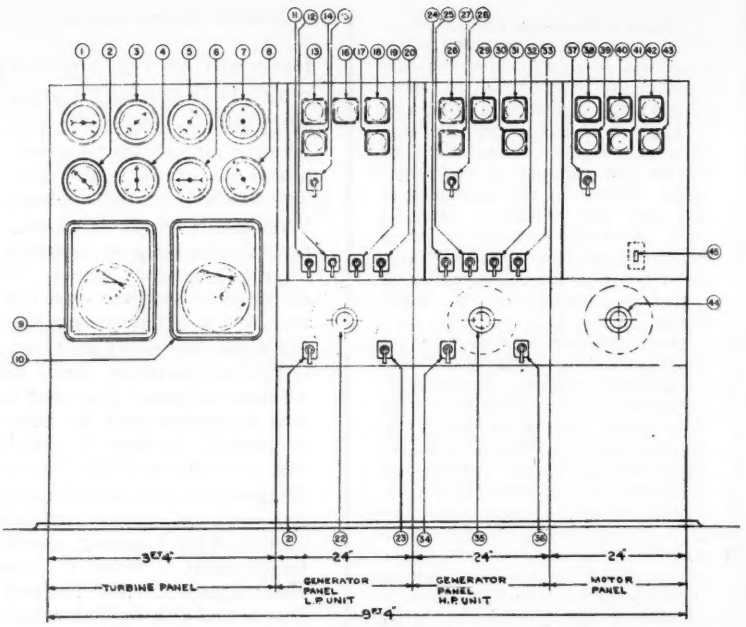


Fig. 4. Details of turbine gage board and electrical switchboard

1—Inlet Steam Pressure at Throttle Valve L.P. Unit
2—Inlet Steam Temperature at Throttle Valve L.P. Unit
3—Exhaust Steam Pressure L.P. Unit
4—Exhaust Steam Temperature L.P. Unit
5—Inlet Steam Pressure at Throttle Valve H.P. Unit
6—Inlet Steam Temperature at Throttle Valve H.P. Unit
7—Exhaust Steam Pressure H.P. Unit
8—Exhaust Steam Temperature H.P. Unit
9—Inlet Steam Flow Recorder L.P. Unit
10—Inlet Steam Flow Recorder H.P. Unit
11—Ammeter Transfer Switch L.P. Unit
12—Governor Motor Control Switch L.P. Unit
13—Ammeter L.P. Unit
14—Tachometer L.P. Unit
15—A.C.B. Switch L.P. Unit
16—Indicating Watt Meter L.P. Unit
17—Frequency Meter L.P. Unit
18—Varmeter L.P. Unit
19—Synchronizing Switch L.P. Unit
20—Voltmeter Switch L.P. Unit
21—Voltage Adjusting Rheostat L.P. Unit
22—Exciter Rheostat L.P. Unit
23—Field Switch L.P. Unit
24—Ammeter Transfer Switch H.P. Unit
25—Governor Motor Control Switch H.P. Unit
26—Ammeter H.P. Unit
27—Tachometer H.P. Unit
28—A.C.B. Switch H.P. Unit
29—Indicating Watt Meter H.P. Unit
30—Frequency Meter H.P. Unit
31—Varmeter H.P. Unit
32—Synchronizing Switch H.P. Unit
33—Voltmeter Switch H.P. Unit
34—Voltage Adjusting Rheostat H.P. Unit
35—Exciter Rheostat H.P. Unit
36—Field Switch H.P. Unit
37—A.C.B. Switch
38—Ammeter
39—Voltmeter
40—Synchroscope
41—Frequency Meter
42—Field Ammeter
43—Voltmeter
44—Exciter Field Rheostat
45—D.P. Toggle Switch

Domestic Electric Consumption Reaches 100 kwhr per Month

AN IMPORTANT MILESTONE in electrical progress in America is indicated by a recent announcement by C. W. Kellogg, President of the Edison Electric Institute, that use of electricity in the home, on a nationwide average, has reached 100 kilowatthours per month per customer. Statistics of the Institute show that for the twelve months ending September 30 average residential electrical consumption was 1200 kilowatthours.

In 1915, Mr. Kellogg said, the average annual consumption of kilowatthours of electricity in the home was 260; by 1930 this figure had climbed to 547, and is now 1200. Thus, average use of electricity in the home has more than doubled every fifteen years during the past three decades, while the average unit cost is less than half what it was twenty years ago.

The continuing gains in the use of electricity were attributed by Mr. Kellogg largely to three factors: continuous promotional efforts by all branches of the electrical industry—including extensive newspaper advertising—which have brought a growing public appreciation of the many conveniences electricity provides for living; the continuing introduction and development of electrical appliances; and early adoption of rate schedules designed to encourage maximum use of electricity by automatically providing lower rates for greater use.

"These practices have brought about an extraordinary contrast in the relationship of the cost of electricity to the cost of living. With the year 1913 representing 100, electricity costs as of September, 1945, have now dropped to 40, while the cost of living has risen to 185. In other words, if electricity had followed the same trend as the general cost of living, electricity costs would now be four and one-half times what they are today.

"Notwithstanding widespread claims of government-ownership proponents that increase in use of electricity and low electricity rates date from such fictitious 'yardsticks' as TVA and other tax-free governmental generating and distribution projects, the pattern of increasing use of electricity and constantly lowered rates has been almost constant since the inception of the electric light and power industry," Mr. Kellogg noted.

"Every since Edison started his Pearl Street Station, the cost of electricity has shown a steady decline. At the end of September, 1945, the average cost of a kilowatthour of electricity was 3.45 cents. This compares with 5 cents ten years ago, 7¼ cents twenty years ago and 8¼ cents at the end of World War I. In 1885 the rate was 24.5 cents per kilowatthour, by 1900 the rate averaged 17 cents."

What the Power Engineer Needs to Know About

The Continuous-Flow Conveyor

What the continuous-flow conveyor is . . . How it operates . . . Advantages and disadvantages . . . Methods of using it for power plant coal handling, compared with alternatives . . . How to calculate its capacity and power required

By

Wilbur G. Hudson

Consulting Engineer

THE CONTINUOUS-FLOW CONCONVEYOR, sometimes called the en masse (i. e., "en mass") conveyor, is the newest member of the family of coal handling machines, and a worthy one—within limits. It is not suited for ashes, because the chain is submerged in a material that is abrasive and often corrosive. Of several hundred boiler house installations contacted or inspected by the writer, only two were found to be unsatisfactory, and these should not have been specified by the manufacturer because both handled bug dust coal, which is abrasive and, when damp, actively corrosive.

In favor of the continuous-flow or en-masse machine are the factors—

It simplifies the layout, often eliminating one unit.

It is inherently dust tight.

It occupies less space than any other mechanical conveyor.

Requires no feeder and is self-loading to capacity.

Operates at slow speed, usually 50-ft per min. or less.

Can have a horizontal, recirculating, runaround path without jamming at the terminals.

Can carry outward and distribute from return run.

As an elevator, can feed out at successive points.

Requires less depth beneath the track.

Costs less than a simple bucket elevator with feeder.

Its handicaps are—

It is not so good for coal containing hard lumps.

It requires more power than a bucket elevator.

The sheet steel duct has not the life of a bucket elevator casing.

The chain cannot have the life of a bucket elevator chain.

The handicaps are negligable in smaller installations, but are increasingly important when the path is long and the capacity large, as in the case of the problems now solved by the inclined belt conveyor or the balanced skip hoist.

Principle and Construction

In the continuous-flow conveyor-elevator, the material moves slowly

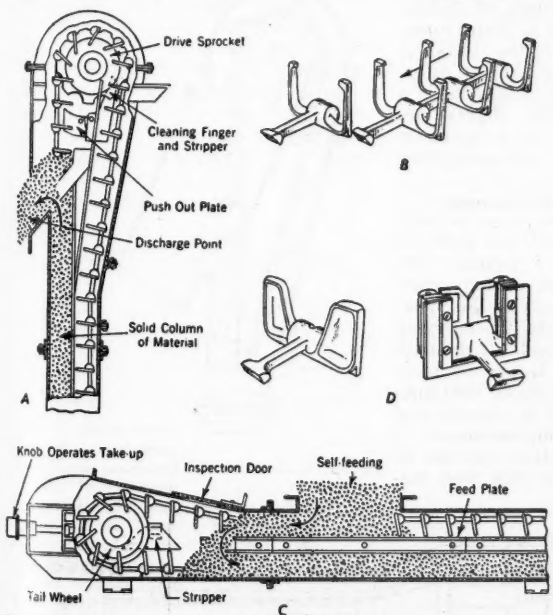


Fig. 1. Redler conveyor details. A—Sectional view at head of elevator. B—Skeleton flights. C—Loading end. D—Two types of cleanout flights

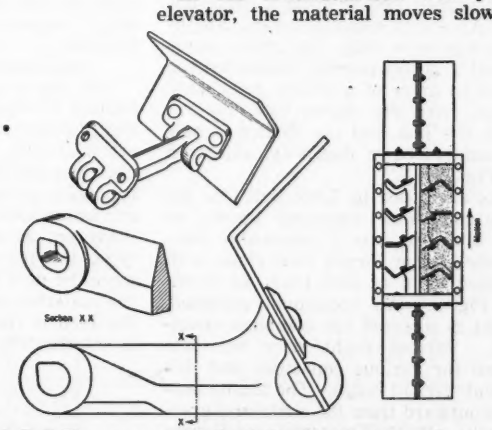


Fig. 2. Bulk-Flo conveyor details. Left—The conveying element of the Bulk-Flo. Peaked flights of various sizes are available for any size of chain to suit desired capacity. Right—Loaded and return runs of a Bulk-Flo elevator. Near middle of return run is a cleanout flight used when complete clean-out of duct is desired or when material is fluid

Fig. 3. Bulk-Flo conveyor, L path, handling coal from bins to distributing screw conveyor over stoker hopper in industrial power plant

Table of comparative sizes of chain-flight continuous-flow or en masse conveyors

Size		Casing Area, square inches	Chain Pitch, inches
		Redler	
No.	3	10.5	3
	5	22.0	4
	7	40.7	5
	9	58.5	6
	11	85.2	7
	13	112.0	8
	15	144.0	9
	17	189.0	10
	19	240.0	11
		Bulk-Flo	
No.	435[1]	16.0	4
	450	22.0	4
	55	31.6	5
	57	42.6	5
	59	53.6	5
	78	65.6	7
	710	80.6	7
	712	95.6	7
	911	117.0	9
	913	136.5	9
	915	156.0	9
		Uni-Flo	
No.	5	22.0	5
	7	37.5	7
	9	57.0	9
	11	85.2	11
	13	113.4	13
	15	145.7	15
		Mass-Flo	
No.	5	22.0	4
	7	37.5	5
	9	57.0	6
	11	85.2	7
	13	113.4	8
	15	145.7	9

[1] These are standard sizes. Flights may vary as required for the capacity; thus the No. 712 has flights about 7 by 12 in. If it had flights 7 by 18 in. it would be referred to as a No. 718.

The manufacturers are making some post-war changes in details that may change duct sizes and chain pitch. These changes will be given in catalogs soon to be issued.

within a closed duct, usually rectangular in cross section, as a continuous core maintained in motion either by closely spaced impellors (flights) or by spaced frames or skeletonized flights. In the latter machine (the Redler) the movement is induced by the coherence of the mass in which the element is submerged. In the other machines there is a direct push. The chain is driven by sprocket at the head end through suitable speed-reduction gearing and motor. It is distinctly a slow-speed machine with a maximum speed of 75 or 80 feet per minute. A speed of 45 to 50 ft p m is desirable.

The conveyor is built as shown in Figs. 1 to 4. The earliest of these conveyors, invented by an Englishman named Redler, used a cable but the American manufacturers, Stephens Adamson Mfg. Co., who introduced it in this country, discarded the cable in favor of a simple detachable chain, with the flights cast integral with the link and the Redler is now manufactured in that way, as shown in Fig. 1.

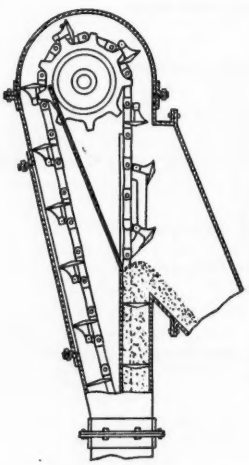
As developed by Link Belt Co., the continuous-flow conveyor known as the Bulk-Flo has a detachable malleable iron or forged steel chain with peaked flight at each pitch, as shown in Fig 2. An occasional modified flight is inserted for complete cleanout. Various flight sizes are provided for various capacities and different sizes of chain. The flights project outward from the chain and practically all the material discharges directly as they emerge from the duct. In elevators, a small residue carries upward and discharges back across a ∧-shaped deflector to rejoin the main discharge. In a conveyor, the flights may be flat with a slight backward slant to eliminate chatter.

The Uni-Flo of Chain Belt Co. has a projecting arm at alternate links to which a flat flight is pivotally attached. As the flights emerge from the duct, they are tilted upward by a revolving cam, chain-driven from the head shaft, and the load discharges outward.

The Mass-Flo conveyor of Jeffrey Mfg. Co., Fig. 4, has a chain somewhat similar to that of the Bulk-Flo, but with a projecting arm at alternate links from which is suspended a tray-like flight. The flights are tilted as they emerge by a fixed cam which projects into their path from the rear.

Characteristics of the Conveyor

Continuous-flow conveyors are self-loading to capacity, will not overload and do not require a feeder. The material feeds into the duct by gravity. The feed is usually to the upper run with a transfer to the carrying run immediately beyond. If the path leads up, as in the L-type or loop-type, the mass movement continues since the duct is filled to capacity and the material cannot slip backward. If the feed is from another machine or is intermittent and so less than machine capacity, spaced cleanout flights may be provided. In the loop type Bulk-Flo, the loading zone is a tangent to the sweep of the curve of the loop.



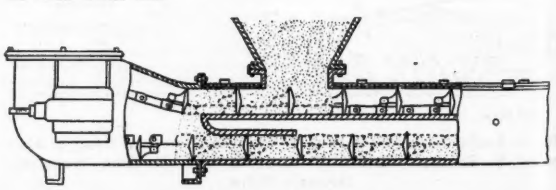


Fig. 4. Conveying elements of the Mass-Flo conveyor

Figs. 1, 2, 4, 9 and 10 and table from Conveyors and Related Equipment, by Wilbur G. Hudson; John Wiley & Sons, Inc., New York.

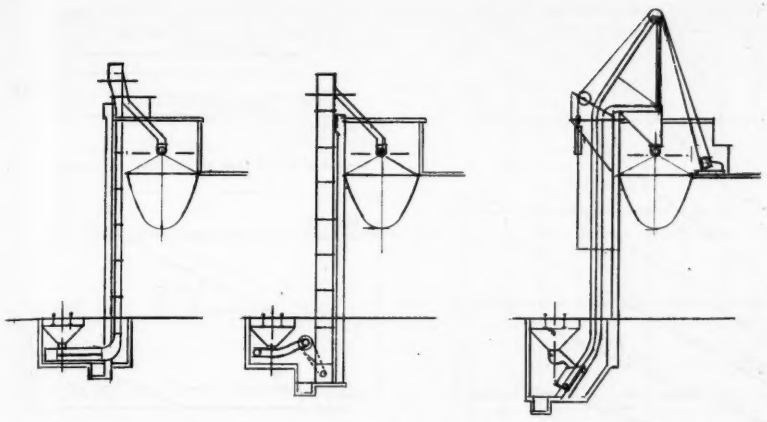


Fig. 5. Comparison of three types of conveyor applied to a problem. A—Solution by use of continuous-flow elevator. B—Solution by use of bucket elevator and apron feeder. C—Solution by use of skip hoist

Since the manufacturers do not use the same methods for designing their sizes, these are shown for four makes in the table.

A succession of feed openings will not overload the machine. The material will feed through the first opening to the capacity of the duct, stopping the feed from following openings until the first feed stops. Similarly there may be a succession of discharge openings, successive chutes or the width of discharge slots may be adjustable.

For automatic feed of coal from an overhead bunker to stoker chutes or pulverizer hoppers, a horizontal run-around continuous-flow conveyor may solve the problem better than other types. It operates at slow speeds with a capacity slightly in excess of the maximum demand. Any surplus coal carries back to the loading point, where the duct is again filled to capacity. Thus any section of the bunker is available for any boiler with completely dustless operation. To prevent the conveyor from plugging in case one or two boilers are taken off the line, an overload stop or signal is easily provided. A variable speed drive permits close adjustment of speed to demand.

Track Hoppers

When necessary, an en masse conveyor may be fed from a track hopper much shallower than is usually required, as in Fig. 11. Under a large hopper, the conveyor duct may be offset so that access to the conveyor from the side is easier for cleaning the duct in case any large coal lumps, tramp iron, or wood get through and jam it.

The usual grid should be placed at track level, although lumps that will pass a 3-in. or 4-in. grid may plug this type of conveyor.

If an elevator discharges to a conveyor of if two or more conveyors are in tandem, the second unit should be given a higher speed than the first. The first loads to the capacity of the duct and if the second has 10 or 15 per cent greater speed, its duct is more comfortably loaded and frictional resistance is reduced.

The continuous-flow conveyor is peculiarly adapted to situations that require not only that the conveyor be dustless but also that it be gas-tight.

How the Continuous Flow Hopper Is Applied

Applications and possibilities of the continuous-flow conveyor are best illustrated by outlines of some layouts and their alternatives.

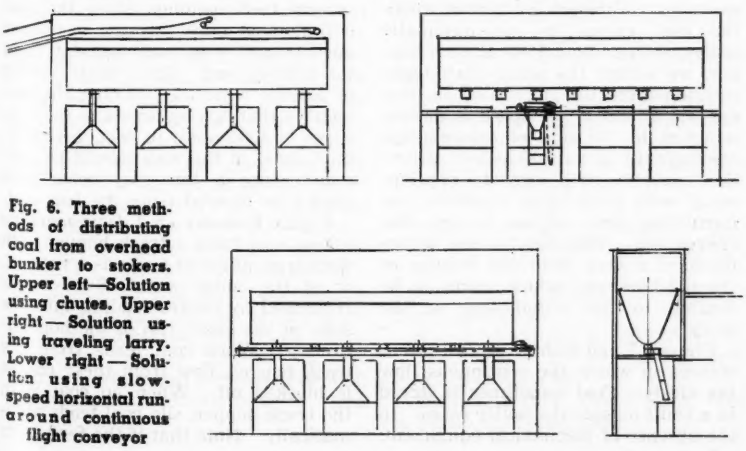


Fig. 6. Three methods of distributing coal from overhead bunker to stokers. Upper left—Solution using chutes. Upper right — Solution using traveling larry. Lower right — Solution using slow-speed horizontal run-around continuous flight conveyor

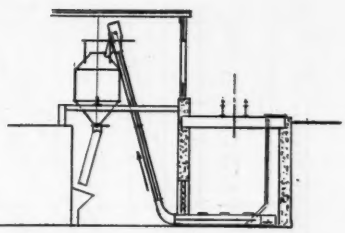


Fig. 7. Continuous-flow conveyor transporting coal direct from storage vault under track to storage hopper over stoker hopper

Figure 3 illustrates a typical small installation: an L-path conveyor-elevator receiving coal from several bin openings and discharging to an overhead screw conveyor which serves a single stoker hopper. When the hopper is filled the conveyors stop automatically and re-start when the hopper is partly emptied.

Figure 5 shows a typical arrangement of overhead bunker and adjacent railroad siding. A capacity of 60 tph (tons per hour) from a track hopper midway along the boiler house is required.

At the left in Fig. 5 is an L-type continuous flow elevator. For this capacity we can specify a machine with 144-sq in. duct area and a speed of 50 ft per min. It requires a 20-hp motor. For distribution we may use a shuttle belt conveyor, a reversible flight conveyor, a continuous-flow conveyor, or a right hand-left hand screw conveyor. As the screw costs about half as much as the continuous-flow and much less than the others, probably it would be specified. The twin verticle duct of the elevator has an outside dimension of 16 in. by 18 in. and can advantageously be inside the boiler room (run through the bunker plate if necessary) so there is no danger of freezing in extremely cold weather.

In the center of Fig. 5 is the layout with bucket elevator and apron feeder. A double-strand continuous bucket machine with 12 in. by 8 in. by 12 in. buckets at 100 ft per min gives us the capacity, and if the feeder is driven from the foot-shaft, a 10-hp

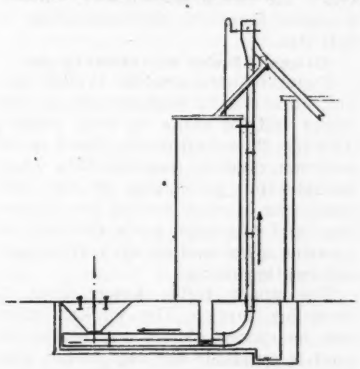


Fig. 8. L-type continuous-flow conveyor transporting coal from track hopper and discharging either to storage silo or to boiler room

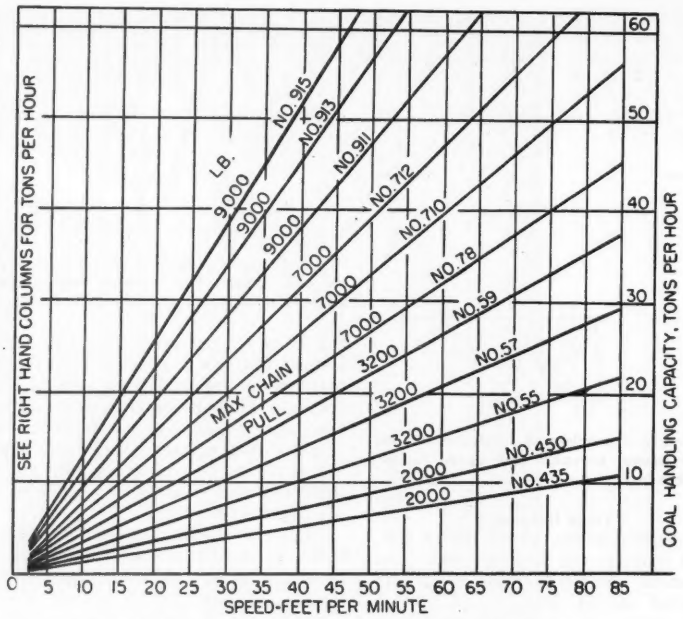


Fig. 9. Coal feeding capacities of Bulk-Flo conveyors at speeds noted

motor is required. The elevator casing is 25 in. by 50 in. in cross section and so probably must be placed outside. We might use a single strand centrifugal discharge elevator with 16 in. by 8 in. buckets at 260 ft per min, but the former will give far longer life.

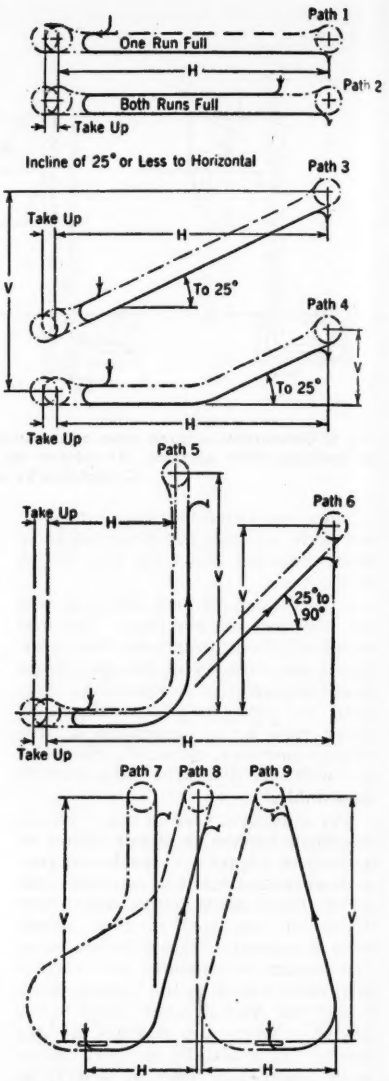
At the right of Fig. 5 is shown an automatic counterweighted skip hoist with 60-cu ft bucket at 120 ft per min using a 12-hp hoist. There is one bad point — there must be a surge hopper to receive the 1½-ton batches. There is no objection to the right hand—left hand screw if it has a central section of smaller diameter or narrower pitch to control the feed.

Here in Fig. 5 we have three competitive layouts. The first will cost much less than the elevator and feeder, and about the same as the skip. The skip will be better if the lift is substantially higher. It requires a pit depth of about 20 ft as compared with 10 ft for the others. Although the continuous-flow requires twice the motor horsepower, that is a minor factor in an installation of this size.

Overhead Bunker with Stoker Chutes

Figure 6 shows another typical layout, an overhead bunker with (at the upper left) a chute to each stoker. This has three bad points: Dead space between chutes; unavailability of a considerable percentage of the coal when one or more boilers are off the line; and with some coals, difficulty in clearing a hot section when spontaneous heating occurs.

The upper right sketch shows a traveling larry. The bunker gates can be spaced closer, any section of coal is available for any boiler, coal from a heated section can be withdrawn continuously, and, if desired, coal can be weighed. The objections are that dust is scattered and that



Path 1
Motor H P = TPH × H × 0.002 × 1.2
Path 2
Motor H P = TPH × H × 0.004 × 1.2
Paths 3 and 4
Motor H P = TPH × [(H × 0.002) + (V × 0.001)] × 1.2
Paths 5 and 6
Motor H P = TPH × (H × 0.0032) + (V × 0.003) × 1.2
Path 7
Motor H P = TPH × (V + 3) × 0.003 × 1.2
Path 8
Motor H P = TPH × [(H × 0.002) × (V × 0.003)] × 1.2
Path 9
Motor H P = TPH × [(H × 0.0035) + (V × 0.003)] × 1.2
Track Hopper
Additional horsepower is usually required when loading the Bulk Flo from a trackhopper.
TPH = tons per hour.
C = material factor,
= 1.2 for coal.
H = horizontal centers in ft.
V = vertical centers in ft.

Fig. 10. Formulas for determining motor horsepower for Bulk-Flo conveyors having various paths when handling coal

frequent manual manipulation is required. The lower right sketch shows the application of a slow-speed, horizontal run-around continuous-flow conveyor. Although we cannot weigh the coal except by an automatic scales costing about $700 at each hopper, we secure the other advantages mentioned for the larry, also dustless operation, and if the speed is closely adjusted to the rate of consumption (perhaps by a variable-speed drive) the conveyor will operate continuously with very little attention, recirculating any surplus in the discharge run. This has become recognized as a very desirable feature of the machine, one which seems to be leading to the elimination of the larry.

Figures 7 and 8 show other circumstances in which the continuous flow fits nicely. Coal sometimes is stored in a vault outside the boiler room. In the absence of mechanical equipment, it is shoveled up into the stoker hopper. With the layout of Fig. 7, the horizontal leg extends back along the floor of the vault. There may be several feed openings, since the coal will flow in only through one—that one covered with coal farthest from the take-up end. Since there is risk of foreign material jamming the element, a shaft giving access to the conveyor is advisable; in fact, a removable panel in the wall should be provided, since a jam may occur that cannot be cleared from the foot end.

Figure 8 shows an L-type machine taking coal from a track hopper with discharge either to a silo as a reserve, or to the boiler room. Silo coal is reclaimed by chutes leading into the sides of the *lower* run of the horizontal leg. When coal feeds from the track hopper, flow from these chutes is blocked off. When no coal is in the track hopper, silo coal feeds automatically. Note that if the feed from

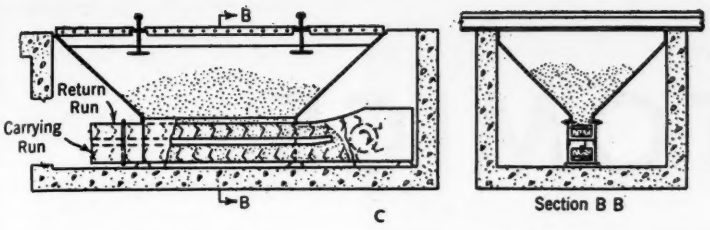


Fig. 11. Shallow track hopper for continuous flow conveyor with feed to return run

the silo were into the return duct as usual, no coal would feed from the track hopper unless the silo chute had cut-off gate.

These outlines are intended to indicate briefly some of the problems which the continuous flow machine solves, either better or with lower investment than the usual types of coal handling equipment. With the lifting of wartime restrictions, improvements are in view, such as alloy steel chains and corrosion resisting ducts.

How to Calculate Power Required

The power requirements of continuous flow machines varies with the path and the friction coefficient of the material as well as with the capacity and speed. To a considerable extent, the formulas given by the manufacturers are derived from actual tests. We will use the data of the Bulk Flo machine. The machines are designated by a number (see table) that indicates approximately the cross section of the conveying duct, thus a No. 915 has a duct acea of 9 by 15 in. approx.; A No. 78 has a duct area of 7 by 8 in., etc.

Figure 9 shows the coal handling capacities for each size at various speeds, and the maximum allowable working loads for the chains.* A speed not exceeding 60 ft per min is advisable. Figure 10 gives the formulas for determining the motor horsepower for various paths or layouts.

Problem: Select a conveyor-elevator for 40 tph, Path 6, with H = 30 ft and V = 40 ft and determine power requirement.

By Fig. 9 we see that we can use a No. 78 at 75 ft per min, a No. 710 at 60 ft or a No. 712 at 52 ft. As low speed is advantageous, the No. 712 is specified. Substituting in the formula for path 6, we have: Motor HP = 40 [(30 × 0.0032) + (40 × 0.003)] × 1.2 = 10.4. Use 10-hp motor.

Checking the chain pull, we find that at 52 ft per min this approximates: (10.4 × 33,000) ÷ 52 = 6580 lb. This is nicely within the limit of 7000 lb. shown in Fig. 9. Were it above the limiting value the solution would not be to increase the speed since this type of conveyor is self-loading to capacity and the rate of handling goes up with the speed. It would be necessary to use the next larger chain at the proper speed.

The manufacturers are making changes in the design and construction of continuous-flow conveyors that will increase their life expectancy, vastly improve the wearing qualities of chains and casings, and make this an even better type of elevator or conveyor than it has been, while retaining the advantages of simplicity, low cost and flexibility.

*The design of the chains in this machine is being modified with the removal of wartime restrictions, so the limitations in Fig. 9 will change. Engineers interested in working through problems like that above should write the manufacturer for the latest ratings.

Oil Circuit Breaker Demonstration Test

(Continued from page 89)

4. Voltage to Neutral (ground) Phase A
5. Voltage to Neutral (ground) Phase B
6. Voltage to Neutral (ground) Phase C
7. Pressure at bottom of tank under oil
8. Travel record

The oscillogram of tests 600-A, 600-B, 601-O to 601-CO3 inclusive show a straight line record for Phase A current and voltage. This was due to a reactor being removed from this phase and the circuit being open. Short circuit tests conducted under these conditions, with the test circuit unbalanced, increases substantially the mechanical strain on the breaker.

The oscillograms indicate that the short circuit interruption time in the series of test range from 4 to 6 cycles. Allowing one cycle relay time, which is within NEMA tolerance, the new line of Roller-Smith oil circuit breakers with "Exothern" arc quenching principle interrupt their full short circuit rating within 5 cycles, which is well within the 8 cycle limit specified by NEMA for this class of breakers.

The following is the sequence of tests conducted on August 19, 1945, with the average current, voltage, and kva values and are identified with the respective oscillograms by their test numbers:

Test No. 1

Oscillogram Identification No.: Test 598-A, 598-B.

Oil Circuit Breaker: Roller-Smith Type 100-TCR-5.

Rated: 7.5 kv, 600 a, 100,000 kva.

Test Cycle: 7.5 kv, 100,000 kva, CO-15-CO.

Actual Average Test Values: 9553 a, 7325 v, 121,000 kva.

Test No. 2

Oscillogram Identification No.: Test 599-A, 599-B.

Oil Circuit Breaker: Roller-Smith Type 100-TCR-5.

Rated: 7-5 kv, 600 a, 100,000 kva.

Test Cycle: 2.3 kv, 25,000 a, 100,000 kva, CO-15-CO.

Actual Average Test Values: 21,-830 a, 2220 v, 83,500 kva.

Test No. 3

Oscillogram Identification No.: Test 600-A, 600-B.

Oil Circuit Breaker: Roller-Smith Type 150-TCR-5.

Rated: 15 kv, 600 a, 150,000 kva.

Test Cycle: 15 kv, 150,000 kva, CO-15-CO.

Actual Average Test Values: 6290 a, 14,650 v, 159,200 kva.

Test No. 4

Oscillogram Identification No.: Test 601-O, 601-CO1, 601-CO2, 601-CO3.

Oil Circuit Breaker: Roller-Smith Type 150-TCR-5.

Rated: 15 kv, 600 a, 150,000 kva.

Test Cycle: 15 kv, 140,000 kva, 0-CO-15-CO-60-CO.

Actual Average Test Values: 5550 a, 14,650 v, 140,500 kva.

Test No. 5

Oscillogram Identification No.: Test 602.

Oil Circuit Breaker: Roller-Smith Type 150-TCR-5.

Rated: 15 kv, 600 a, 150,000 kva.

Test Cycle: 3.5 kv, 25,000 a, 150,000 kva Opening.

Actual Average Test Values: 24,300 a, 3775 v, 159,000 kva.

Test No. 6

Oscillogram Identification No.: Test 603.

Oil Circuit Breaker. Roller-Smith Type 150-TCR-5.

Rated: 15 kv, 600 a, 150,000 kva.

Test Cycle: 3.5 kv, 25,000 a, 150,000 kva CO.

Actual Average Test Values: 23,210 a, 3775 v, 151,600 kva.

FINISHING time in machining and aircraft part has been reduced from 13½ hours to 5 minutes with an electronic motor control widely used in war production.

IT IS roughly estimated that 90 per cent of the radiant emission from the fire fly is luminous, closely approaching 500 lumens per watt. This is ten times the ultimate efficiency that could be expected from a tungsten filament lamp since tungsten when melting at about 3655 deg Kelvin could generate visible light at no better than 55 lumens per watt. If such a lamp were to burn for several hours, an efficiency of 35 lumens per watt would more correctly represent a practical top limit.

ATOMICS

A New Section added to POWER PLANT ENGINEERING to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

THE DEVELOPMENT OF ATOMIC ENERGY

This is the second of a series of articles giving a general account of the development of methods of using atomic energy for military purposes under the auspices of the United States Government. The first article discussing the events which led to the idea of producing plutonium by a chain nuclear reaction and of separating U235 from natural uranium appeared in the October issue. This second article describes in detail the design and construction of the first self-sustaining nuclear reaction pile at the University of Chicago which went into operation for the first time on December 2, 1942. These articles are based upon the official report by H. D. Smyth, Chairman of the Department of Physics of Princeton University.

By Andrew W. Kramer ***Managing Editor, Power Plant Engineering***

AS EXPLAINED in the first article in the October issue, by the end of 1941, a great deal of preliminary study on the possibility of producing an atomic bomb had been completed. It appeared quite within the realm of possibility that if a sufficient quantity of U-235, or Pu-239 could be brought together quickly enough, an explosion of superlative destructive power would result. Because of the "critical size" factor, a small amount of U-235 or Pu-239 could not produce explosive fission under any circumstances, but once the quantity exceeded a certain critical mass, it would explode spontaneously. From calculations and studies that had been made, it seemed that this mass necessary to produce explosive fission could hardly be less than 2 kilograms (4.4 lb) nor did it need to be greater than 100 kilograms (220 lb). These wide limits reflected the experimental uncertainty in the capture probability for *fast* neutrons. It must be remembered that for a bomb, a *fast* neutron reaction was necessary. For the production of plutonium from uranium 238, as explained in the preceding article, a slow neutron reaction, due to the use of a moderator, was desirable. It had also been calculated that the available explosive energy per kilogram of uranium is equivalent to about 300 tons of TNT.

Time was an extremely important element. British "Intelligence" uncovered the fact that several kilograms of heavy water a day were being produced in Norway and that Germany had ordered considerable quantities of paraffin to be made using heavy hydrogen; it was difficult to imagine a use of these materials other than in work on the uranium problem. The Allies (though we were not in the war actively at that time) feared that if the Germans got atomic bombs before they (the Allies) did, the war would be over in a few weeks.

In December, 1941, Pegram and Urey, two of our scientists, had come back from a trip to England and reported on the work going on there. This had been following much the same lines as in this country. Pegram and Urey brought back with them a sense of urgency.

In the meantime, Vannevar Bush had taken the whole question of uranium research up with President Roosevelt and Vice President Wallace. He summarized for them the British views, which were on the whole optimistic, and pointed out the uncertainties of the predictions. The President agreed that it was desirable to broaden the program, to provide a different organization, to provide funds from a special source, and to effect complete interchange of information with the British.

As already explained, two principal problems had to be solved before the actual production of an atomic bomb could be undertaken. One involved the development of isotope separation methods, leading to the production of U-235 and the other involved the production of plutonium, Pu 239, from U-238 by a self-sustaining reaction pile. The problems of isotope separation had been assigned to groups under E. O. Lawrence and H. C. Urey, while the plutonium project was assigned to A. H. Compton's group, which was organized under the cryptically named "Metallurgical Laboratory" of the University of Chicago, as already explained.

In this article, we will describe briefly the work of the Metallurgical Laboratory and the associated laboratories. In accordance with the general objectives of the project the initial objectives of the Metallurgical Laboratory were: first, to find a system using normal uranium in which a chain reaction would occur; second, to show that, if such a chain reaction

did occur, it would be possible to separate plutonium chemically from other material; and, finally, to obtain the theoretical and experimental data for effecting an explosive chain reaction with either U-235 or with plutonium. The ultimate object of the laboratory was to prepare plans for the large-scale production of plutonium and for its use in bombs.

Procurement of Materials

Before anything could be done towards the development of a chain reaction system for the production of plutonium it was necessary to procure a sufficient amount of materials of sufficient purity. As far as uranium was concerned, it seemed likely that it would be needed in highly purified metallic form or at least as highly purified uranium oxide. The other materials which were going to be needed were either graphite, heavy water, or possibly beryllium. It was clear at this time that, however advantageous heavy water might be as a moderator, no large quantities of it would be available for months or years. Beryllium seemed less advantageous and almost as difficult to get. Therefore, the procurement efforts for a moderator were centered on graphite.

At the end of 1941 the only uranium metal in existence was a few grains of good material made on an experimental basis by the Westinghouse Electric Corporation and a few pounds of highly impure pyrophoric powder made by the Metal Hyrides Company. The only considerable amount of raw material then available in this country was in the form of a commercial grade of black uranium oxide which could be obtained in limited quantities from the Canadian Radium and Uranium Co. It contained from 2 to 5 per cent of impurities and was the material which gave a neutron amplification factor of only about 0.87 when used in a "pile." To produce a self-sustaining reaction, the neutron multiplication factor would have to be in excess of 1.0.

By May, 1942, deliveries averaging 15 tons a month of black oxide of higher purity and more uniform grade started coming in. Total impurities were less than 1 per cent, boron comprised a few parts per million, and the neutron multiplication factor (k) was about 0.98. The multiplication factor, however, also depended on the purity of the graphite used as the moderator. Deliveries of the black oxide reached a ton a day in September, 1942.

Experiments at the National Bureau of Standards by J. I. Hoffman demonstrated that, by the use of an ether extraction method, all impurities are removed by a single extraction of uranyl nitrate. The use of this method removed the bulk of the difficulties in securing pure materials for the production of metal. Early in May, 1942, arrangements were completed with the Mallinckrodt Chemical Works in St. Louis to put the new grade of oxide through either an extraction process on a production basis for a further reduction in impurity content and to deliver the final product as brown oxide. Deliveries started in July, 1942, at a rate of 30 tons a month. This oxide is now used as a starting point for all metal production, and no higher degree of purity can be expected on a commercial scale.

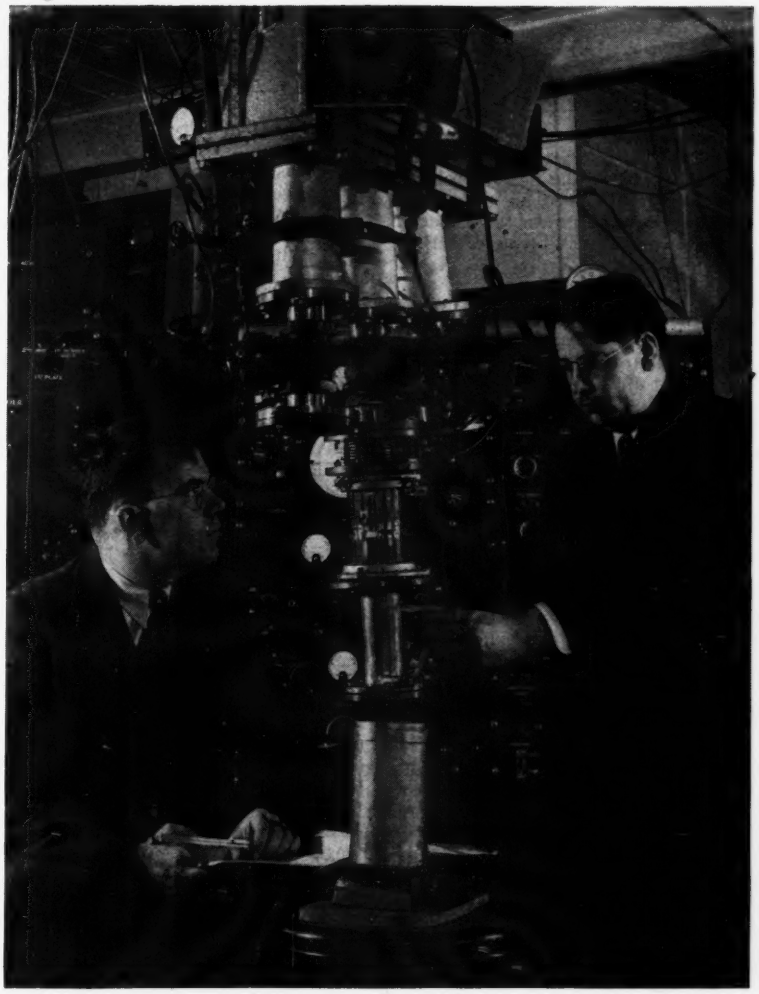


Fig. 1. Target End of Atom-Smasher—Dr. E. U. Condon, former associate director, of the Westinghouse Research Laboratories, left, and Dr. Jerald E. Hill, research physicist, at the target end of the Westinghouse 90-ton atom-smasher. Early discoveries made on this first industrial atom-smasher, built in 1937, contributed to the general store of knowledge which made the atomic bomb possible. Dr. Condon has recently been made Director of the National Bureau of Standards

At the same time intensive research went on in the production of the uranium metal. Westinghouse had developed a process producing the metal at a cost of about $1000 a lb. Subsequent developments, however, resulted in new processes and by November, 1942, some 6000 lb of the metal had accumulated and the rate of production by Westinghouse was expected to reach 500 lb per day by January, 1943. The purity of the metal was good, and the cost had dropped to $22 per lb.

Metal Hyrides Co. also was producing the metal but neither the Westinghouse process or the Metal Hyrides process was entirely satisfactory. Intensive activity designed to accelerate metal production and carried out independently by F. H. Spedding and his association at the University of Iowa, and by C. J. Rodden at the National Bureau of Standards, resulted in the development of a satisfactory method. Production facilities were set up at Ames in the fall of 1942 and these had already produced more than one ton by the end of November. The process was extremely simple, rapid and low in cost.

Research on graphite production also had proceeded. This was quite different from the metal production since the industrial production of

ATOMICS

graphite had already been very large. The problem was merely one of purity and priority. The purity problem was essentially solved by the middle of 1942 and large orders were placed with the co-operation of the War Production Board.

The Chain Reaction

At the time the Metallurgical Project was organized, most of the physicists familiar with the problem believed that a chain-reacting pile probable could be built if sufficiently pure graphite and pure uranium metal could be obtained. Nevertheless, there were uncertainties in the experimental data and in the approximations that had to be made in the theoretical calculations. There were two alternatives: (1) to build a pile according to the best possible design; (2) to make more accurate determinations of the pertinent nuclear constants, to perform intermediate experiments, and to improve the calculations. There was little doubt that the first alternative was the one most likely to lead most rapidly to the production of plutonium but unfortunately the necessary amounts of material were not available and did not become available for nearly nine months. Consequently, it was necessary to choose the second alternative.

A number of intermediate experiments wers made during the early part of 1942 and all of these strengthened the confidence of the group in the belief that a pile could be built with a neutron production-escape ratio greater than unity. In July enough purified uranium oxide from Mallinckrodt was available to permit the building of intermediate pile No. 9. As in previous experiments, a radium beryllium neutron source was placed at the bottom of the lattice structure and the neutron density measured along the vertical axis of the pile. By this time it was known that the neutron density decreased exponentially with increasing distance from the neutron source (hence the name often used for experiments of this type, "exponential pile") and that, from such rates of decrease, the neutron multiplication constant, k, could be calculated. For the first time, the multiplication constant, k, so calculated from experimental results came out *greater than one.* (The actual value was 1.007.)

We cannot describe, or even mention, all the various auxiliary experiments done during this period but there was one that deserves mention. This was the study of "delayed neutrons." From previous investigations, it was known that about 1 per cent of the neutrons emitted in fission processes were not ejected immediately but were given off in decreasing quantity over a period of time. Several half-lives had been observed, the longest being of the order of a minute. It was realized that this time delay gave a sort of inertia to the chain reaction that should facilitate control. If the effective multiplication factor of a pile became slightly greater than 1, the neutron density would not rise to harmfully large values almost instantly but would rise gradually so that there would be a chance for controls to operate. As a result of further study and measurement of this delay effect, it seemed evident that 1.0 per cent of the neutrons emitted in uranium fission are delayed by at least 0.01 second and that about 0.7 per cent are delayed by as much as a minute. By designing a pile such that the effective value of k, the multiplication factor, is only 1.01 the number of delayed neutrons is sufficient to allow easy control.

The First Self-Sustaining Chain-Reacting Pile

By the fall of 1942 enough graphite, uranium oxide, and uranium metal were available at Chicago to justify an attempt to build an actual self-sustaining chain-reacting pile. The pile was constructed on the lattice principle with graphite as a moderator and lumps of metal or oxide as the reacting units regularly spaced through the graphite to form the lattice. Only about 6 tons of the metal were available so many of the lattice points consisted of uranium oxide.

The original plan called for an approximately spherical pile with the best materials near the center. Actually control measurements showed that the critical size had been reached

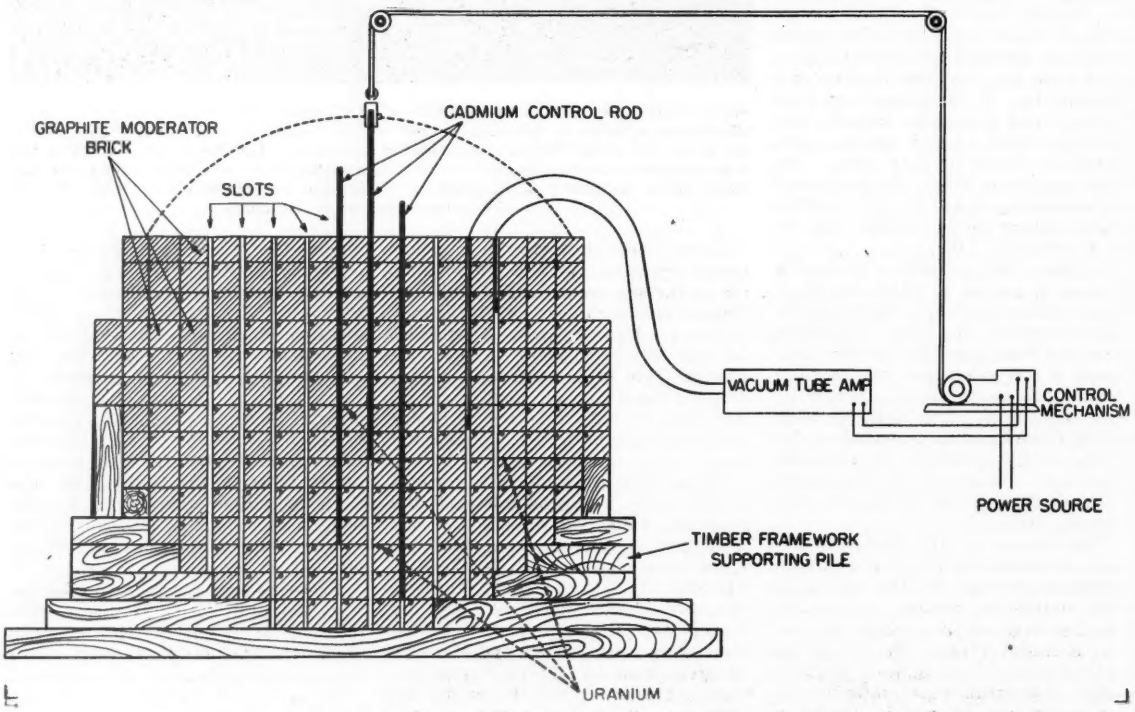


Fig. 2. A diagram showing the general features of the first self-sustaining nuclear reaction pile at the University of Chicago which went into operation on December 2, 1942. This diagram was drawn from the general information contained in the Smyth report and is not a drawing of the pile as it was actually constructed

before the sphere was complete, and construction was modified accordingly. The final structure may be roughly described as an oblate spheroid flattened at the top, i.e., like a door knob. It was desired to have the uranium or the uranium oxide lumps spaced in a cubic lattice imbedded in graphite. Consequently, the graphite was cut in bricks and built up in layers, alternate ones of which contained lumps of uranium at the corners of squares. The critical size was reached when the pile had been built to a height of only three-quarters of that needed according to the most cautious estimates. Consequently only one more layer was added. The graphite used was chiefly that from the National Carbon Co. and the Speer Graphite Co. The pile contained 12,400 lb of metal, part of which was supplied by Westinghouse, part by Metal Hydrides, and part by Ames (University of Iowa). Since there were many more lattice points than lumps of metal, the remaining ones were filled with pressed oxide lumps.

For purposes of control and experiment there were ten slots passing completely through the pile. Three of those near the center were used for control and safety rods. Further to facilitate experiment, particularly the removal of samples, one row of graphite bricks carrying uranium and passing near the center of the pile was arranged so that it could be pushed completely out of the pile. This whole graphite sphere was supported by a timber framework resting on the floor of the squash court under the west stands of Stagg football field. Specific details of the construction have not been released but from the description just given, the pile probably was constructed somewhat as shown in Fig. 2. The uranium metal lattice was placed at the center of the pile; the oxide lattice made up the bulk of the rest of the pile. There were in fact three lattices; the metal lattice and two oxide lattices. The metal lattice had a multiplication factor of 1.07 and the oxide lattices had multiplication factors of 1.04 and 1.03, the difference in the last two resulting from the grade of graphite used. These multiplication factors were calculated for lattices of infinite size. Although the original design of the pile had been deliberately generous, its success when only partly completed indicated that the values of the multiplication factors as calculated from exponential experiments had been too low. The observed effective multiplication factor of the part of the planned structure actually built was about 1.0006 when all neutron absorbers were removed.

A series of measurements was made while the pile was being assembled in order to be sure that the critical dimensions were not reached inadvertently. These measurements served also to check the neutron multiplication properties of the structure during assembly, making possible a prediction of where the critical point would be reached.

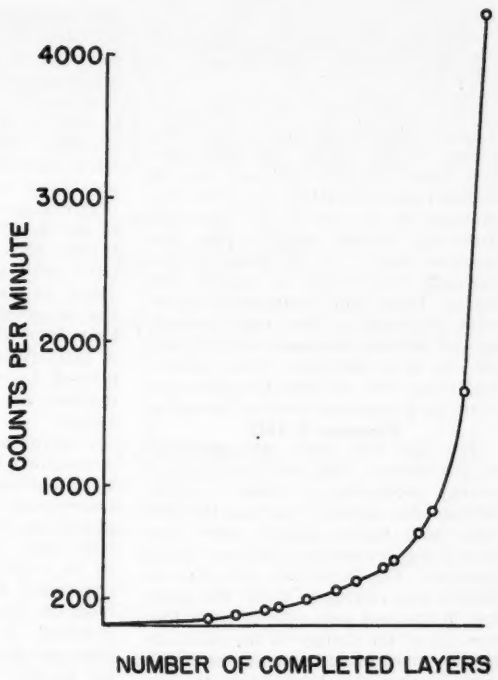


Fig. 3. Curve showing the growth of neutron activity of the pile as the layers were added

In general, any detector of neutrons or gamma radiation can be used for measuring the intensity of the reaction. Actually both neutron detectors (boron trifluoride counters) and gamma-ray ionization chambers were distributed in and around the pile. Certain of the ionization chambers were used to operate recording instruments and automatic safety controls. In the pile itself measurements were made with two types of detectors. A boron trifluoride counter was inserted in a slot about 43 in. from the ground and its readings taken at frequent intervals. In addition an indium foil was irradiated every night in a position as close as possible to the effective center of the pile, and its induced activity was measured the following morning and compared with the readings of the boron trifluoride counter.

By means of these measurements it was possible to determine the increase of neutron activity as the construction of the pile proceeded. Furthermore, by plotting the results of the readings it was possible to predict the effective radius of the pile and at what layer it would become self-sustaining. Fig. 3 shows the growth of the neutron activity of the pile as the number of layers increases. As will be noted, the activity rapidly increased as the critical layer was approached.

During the construction, appreciably before reaching this critical layer, some cadmium strips were inserted in suitable slots. These were removed once every day with the proper precautions in order to check the approach to the critical conditions. The construction was carried in this way to the critical layer.

It was fortunate that these control strips were placed in "retard" positions from the start since the approach to the critical condition was found to occur at an earlier stage of the assembly than had been anticipated.

The reaction was controlled by inserting in the pile some strips of neutron-absorbing material—cadmium or boron steel. When the pile was not in operation, several such strips were inserted in a number of slots, bringing the effective multiplication factor considerably below one. Besides the cadmium strips that could be used for manual operation of the pile, two safety rods and one automatic control rod were provided. The automatic rod was operated by two electric motors responding to an ionization chamber and amplifying system so that, if the intensity of the reaction increased above the desired level, the rod was pushed in and vice versa. Schematically, the control arrangement is indicated in Fig. 2.

Operation of the Pile

To operate the pile all but one of the cadmium strips were taken out. The remaining one was then slowly pulled out. As the critical condition was approached, the intensity of the neutrons emitted by the pile began to increase rapidly. It should be noted, however, that when this last strip of cadmium was so far inside the pile that the effective multiplication factor was just below one, it took a rather long time for the intensity to reach the saturation value. Similarly,

if the cadmium strip was just far enough out to make the multiplication factor greater than one, the intensity rose at a rather slow rate. For example, if the rod is only 1 cm out from the critical position, the "relaxation time," i.e., the time for the intensity to double, is about four hours. These long "relaxation times" were the result of the small percentage of delayed neutrons which have already been discussed. They make it relatively easy to keep the pile operating at a constant level of intensity.

December 2, 1942

The pile first went into operation on December 2, 1942, with a maximum energy production of about ½ watt. So far as is known, *this was the first time that human beings ever initiated a self-maintaining nuclear chain reaction.* On December 12th the intensity was run up to about 200 watts but it was not felt safe to go higher because of the danger of the radiation to personnel in and around the building. During this high intensity run, measurements were made of radiation intensity beside the pile, in the building and on the sidewalk outside.

This experiment, performed on December 2, 1942, just as a reviewing committee was appraising the Chicago project, answered beyond all shadow of doubt the first question before the Metallurgical Laboratory; *a self-sustaining nuclear chain reaction had been produced in a system using normal uranium.* This experiment had been performed under the general direction of E. Fermi, assisted principally by groups headed by W. H. Zinn and H. L. Anderson. V. C. Wilson and his group had been largely responsible for developing the instruments and controls, and a great many others in the laboratory had contributed to the success of the enterprise.

Relation Between Power and Production of Plutonium

The immediate object of building a uranium-graphite pile was to prove that there were conditions under which a chain reaction would occur, but the ultimate objective of the laboratory was to produce plutonium by a chain reaction. Therefore we are interested in the relation between the power at which a pile operates and the rate at which it produces plutonium. A pile running stably must be producing as many neutrons as it is losing. For every thermal neutron absorbed in U-235 a certain number of neutrons, n, is emitted. One of these neutrons is required to maintain the chain. Therefore, assuming the extra neutrons are all absorbed by U-238 to form plutonium, there will be $n-1$ atoms of Pu 239 formed for every fission. Every fission releases roughly 200 million electron-volts (Mev) of energy. Therefore the formation of $n-1$ atoms of plutonium accompanies the release of about 200 Mev. Since $n-1$ is a small number, we can guess that to produce a kilogram a day of plutonium a chain reacting pile must be releasing energy at the rate of 500,000 to 1,500,000 kw. The first chain-reacting pile that we have just described operated at a maximum of 200 watts. Assuming that a single bomb required the order of one to 100 kilograms of plutonium, the pile that has been described would have to be kept going at least 70,000 years to produce a single bomb. At that stage of the work it was evident that even though the possibility of a self-sustaining reaction had been proved, the problem of quantity production of plutonium was not yet solved.

A great achievement had been accomplished, however. The process had been worked out; now, what was necessary was the development of the principles discovered into a large scale plant. Another problem that had to be solved was the feasibility of separating the plutonium, chemically from the other material with which it is found. It would entail more space than can be devoted to this phase of the project here to describe in detail how the chemistry of plutonium problem was solved but it was, in fact, by the end of 1942, plutonium, an entirely unknown element eighteen months earlier, was considered an element whose chemical behavior was as well understood as that of several of the elements of the old periodic table.

Preliminary studies were made with microscopic quantities of plutonium. Such quantities were produced by prolonged bombardment of several hundred pounds of uranyl nitrate with neutrons obtained with the aid of cyclotrons, first at Berkely and later at Washington University in St. Louis. By the end of 1942, something over 500 micrograms had been obtained in the form of pure plutonium salts. Although this amount is less than would be needed to make the head of a pin, for the micro-chemists it was sufficient to yield considerable information.

The Fast Neutron Reaction

So much for the plutonium production problem. The third initial objective of the Metallurgical Project was to obtain theoretical and experimental data on a "fast neutron" reaction, such as would be required in an atomic bomb. This aspect of the work was initially planned and coordinated by G. Breit of the University of Wisconsin and later continued by J. R. Oppenheimer of the University of California. Since the construction of the bomb was to be the final part of the program, the urgency of studying such reactions was not so great. Consequently little attention was given to the theoretical problems until the summer of 1942, when a group was organized at Chicago under the leadership of Oppenheimer.

In the meantime experimental work initiated, in most cases by G. Breit, had been in progress (under the general direction of the Metallurgical Project) at various institutions having equipment for fast neutron studies (Carnegie Institution at Washington, the National Bureau of Standards, Cornell University, Purdue University, University of Chicago, University of Minnesota, University of Wisconsin, University of California, Stanford University, University of Indiana and Rice Institute. The problems under investigation involved scattering, absorption and fission probabilities, the energy spectrum of fission neutrons, and the time delay in the emission of fission neutrons. For the most part the work represented an intermediate step in confirming and extending previous measurements but reached no final conclusion. This type of work was subsequently concentrated at the atomic bomb laboratory at Los Alamos, New Mexico.

As indicated in a feasibility report issued toward the end of 1942, the picture had changed significantly in only one respect since the appearance of the National Academy Report a year earlier. Theoretical studies now showed that the effectiveness of the atomic bomb in producing damage would be greater than had been indicated in the National Academy Report. However, critical size of the bomb was still unknown. Methods of detonating the bomb had been investigated somewhat, but on the whole no certain answers had been reached.

NOTE: This is the second of a series of articles on the development of atomic energy. A third will appear in a subsequent issue.

Are Research Scientists People?

(Continued from page 69)

One more distinction should be noted. The research scientist does not sell knowledge; that is the job of the consultant or "expert" on a given subject. What the researcher sells is his service in discovering and piecing together facts. Knowledge is to him what tools are to a carpenter. When one wants to buy tools one goes to a hardware store. The carpenter is called in when one wants to buy service in the application of his tools.

The industrial research scientist is well trained in his particular specialty. In addition, although he is not a cost accountant, he knows something of costs and doesn't have to be reminded that they are important to manufacturing. He is a scientist in overalls. If he has been in the profession for even a few years he has seen the inner workings of quite a few industrial processes, and probably has helped to solve some of their problems. He has a technique for finding solutions. And now, if you have brought him your research problem, you may be disappointed to find that he is not the leading expert on your product. Possibly he has never heard of your product. He does not know the answer to your problem. Neither does the leading expert.

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Burning Tar Under Power Boilers

The conversion of a hand-fired water tube boiler into a tar-bburning unit, solved the problem of The Lawrence Gas & Electric Company's problem of what to do with the bunker "C" tar that resulted from their gas manufacturing operations. Tar stored in an outdoor tank, heated with 2-in. manually controlled heating coils is pumped to the burners at a temperature of about 200 F.

By Herman Laudani

Chemist, Lawrence Gas & Electric Company
Lawrence, Massachusetts

ALTHOUGH the use of heavy tars as boiler fuel is somewhat of an old story, the application of modern equipment and engineering has solved the problem of disposal of Bunker "C" tar in our particular case very satisfactorily.

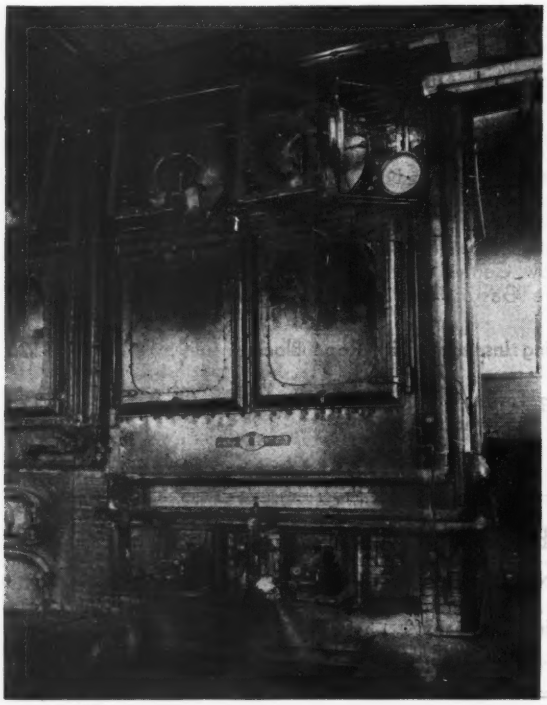
To accomplish this, the conversion of one of our Babcock & Wilcox hand-fired water-tube boilers for tar burning was necessary. The Service Company made a survey of the problem, drew up the plans and specifications, after which orders were placed with the W. N. Best Engineering Company to supply us with the proper equipment. The installation of the tar-burning equipment was accordingly started in April and completed on June 10, 1940, at which date the two tar burners were put into operation.

For the size of boiler involved, the W. N. Best Engineering Company recommended Series 10 Burner, each unit completely assembled consisting of burner, mounting box with its primary air intake dampers, shield for protecting the burner when in a non-firing position, steam and tar throttling valves, and pressure gage for controlling the atomizing steam. In operation, the pre-heated tar (195 degrees Fahrenheit), conveyed to the throttling valve of the burner under a gage pressure of 15-20 psi, goes through a slot-like orifice over which high pressure steam is passed, thereby producing a fan-like spray of tar. The tar, atomized into a fine mist and ignited by means of a gas pilot located adjacent to the burner unit, directs itself downward into the combustion chamber of the boiler at an angle of 15 degrees with the horizontal. The burner unit is so constructed that facilities are provided for the thorough cleaning of the burner without removal from the furnace.

Burner Control

The burner control or increment valve is a slide type of valve with a "V" opening in the body. Due to the erosive action of the tar, this "V" opening becomes so enlarged after two months of operation that it necessitates removing the valves from the line, taking them apart, and building up this "V" opening by bronze welding, and then filing it to the proper shape. The tar burner head bodies also suffer from this erosive action and periodically are likewise built up by bronze welding. This method of rebuilding these parts by brazing has saved us considerable expense since the date of installation, not only in replacement costs, but also in permitting us to have on hand only two spare burners and two spare valves.

The boiler setting had to be changed for tar burning, and in this respect the specifications set down by the Service Company were closely adhered to. The cast-iron fire box front with its firing doors, dampers, and ash pit doors were removed as were the iron grate bars. The ash pit was lowered about 1½ ft, the furnace sidewalls and facing were relined with firebrick 9-in. in thickness, and



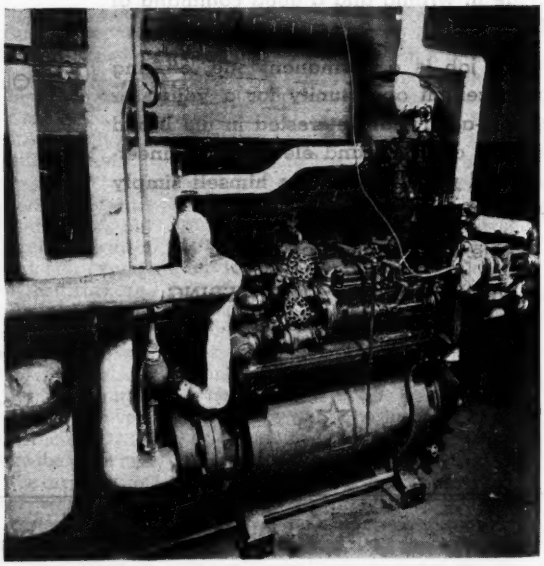


Fig. 1 (Left) Lawrence Gas & Electric Company's tar-burning installation on a 264 hp water tube boiler
Fig. 2 (Above) Tar pumps, heat exchanger, strainer and controls

provision was made for two peep holes on the outside wall to permit the operator to observe the fire condition in the combustion chamber and so be better able to regulate the burner. An inclined grate made of firebrick supported on 4-in. channels with slots 2½ by 9-in. in area was installed with a slope of 15 degrees with the horizontal, the same angle at which the tar spray is projected into the furnace. The inclined grate serves a dual purpose. First, it permits secondary air to be drawn into the combustion chamber and second, it allows particles of carbon and extraneous matter to fall through the grates into the ash pit and be removed from the furnace. The intake of secondary air is controlled by a set of dampers located on the bottom front of the boiler beneath the grates. These dampers are adjustable by means of a hand-operated damper control wheel. Two steel panels for the burner mounting were also installed on the front of the furnace.

Tar and Steam Piping

Modifications of the original installation of the pump unit, tar and steam piping, and tar storage facilities have been made at various periods to assure smoother performance of the tar-burning boiler. The source of tar supply was originally a 139,000 gal tank located adjacent to the boiler house. As this tank was converted in 1943 to heavy oil storage, it was then replaced by an 8,000 gal overhead tank horizontally mounted on a platform to provide a constant pressure head of 8 or 9 ft to the pump. Located about 25 ft outside the boiler house, this tank is equipped with 2-in. heating coils in which the steam is manually controlled, and well insulated to maintain a constant tar temperature.

A well insulated 2-in. tar suction line runs from the storage tank underground to the pumping unit in the boiler house. Here it enters a suction strainer of the steam purging type equipped with a 3-in. by-pass. This strainer is by-passed once every 24 hours and blown out with steam into a sump located outdoors. Incidentally, this strainer has been opened up only twice since its installation—once for cleaning and inspection, and once for installing a new screen. This strained tar then goes to one of a pair of 3½ by 2¼ by 4 in. horizontal Worthington duplex steam pumps connected in parallel where the inlet temperature is maintained at about 160-180 F. The installation of the spare pump in parallel was made approximately a year after the original installation. The pistons at the tar end of these pumps with ball rings and follower plates are composed of cast iron, and must be renewed every six months.

The tar then passes through a secondary heater located directly beneath the pump unit. The temperature at the outlet of the secondary heater, which is thermostatically controlled at about 195-200 F by means of a Sylphon temperature regulator, is maintained by utilizing exhaust steam from the pump and make-up high pressure steam. The pressure at the pump outlet is controlled by a pump governor or antipulsator with a mounted pressure gage kept at 15-20 psi. A pressure relief valve is provided on the secondary heater and pump discharge for precautionary measures.

The discharge line from the pump runs horizontally across the boiler front with an individual line from this 2-in. header to each burner. A relief valve and a by-pass valve is provided at the end of this header for the return line to the top of the tar storage tank. The by-pass valve is always kept partially open to maintain a steady circulation throughout the system.

When the tar burners were put into operation, some difficulty was experienced in maintaining the tar sufficiently hot to flow at the burners. This was undoubtedly due to the fact that the viscosity of Bunker "C" tar increases enormously with a slight drop in temperature. To correct this trouble, steam heated copper tubing was spirally wound around the tar lines extending from the storage tank to the pump and from the pump to the burners, after which the tar piping was properly insulated. The desired effect resulted and no further trouble came from this source. Since the tar pump unit is located at the southwest corner of the boiler house adjacent to a large door which is opened now and then, a brick housing was provided for the pump unit to prevent a recurrence of the temperature trouble during severe weather conditions in winter.

The tar burners have given very satisfactory service to date. There have been occasions, naturally, when the flame became extinguished and smoked excessively at the stack, due undoubtedly to the excessive water content in the tar emulsions. When, however, stable conditions in the tar lines were re-established, the smoking nuisance and burner trouble ceased. Formerly, this trouble occurred more frequently because the undehydrated tar was pumped directly from the tar separators to the storage tank, resulting in having to

"— and don't forget we need two men for the boiler room, too!"

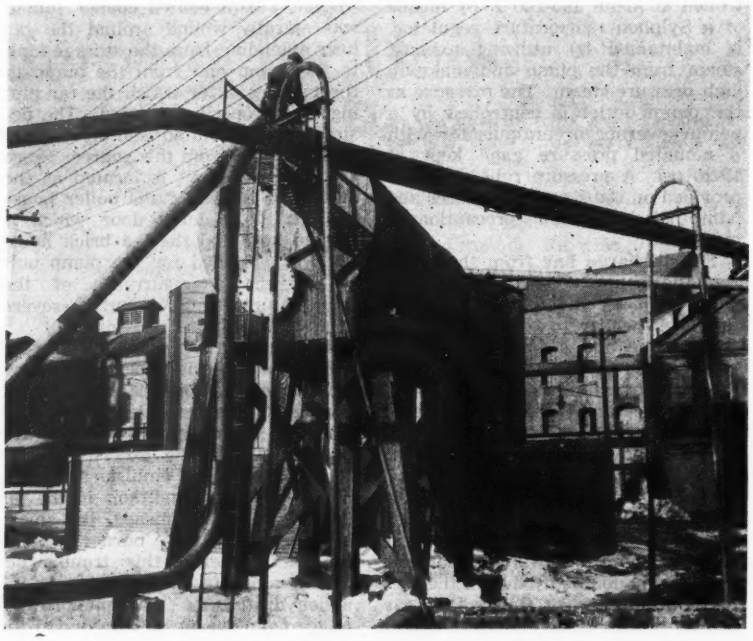


Fig. 3 Overhead tar supply tank with gravity feed to pumps

burn emulsions containing large percentages of water. Our practice now is to pump the tar from the separators to an underground wooden tank where steam coils heat and partially dehydrate the tar, after which it is pumped to the tar storage tank.

Although it has been found that tar burners can handle tars containing up to 10 per cent water content quite efficiently, it has been observed that too-dry tar will not burn as well as tar with 4 or 5 per cent water content, and that tar containing over 10 per cent water causes sputtering at the burners, attendant with smoke and soot formation. After considerable experimentation, it was found that tars possess critical temperatures and pressures at which these emulsions will burn efficiently without forming slag, soot or smoke.

Deposit of soot in the boiler tubes is at times, however, unavoidable, and if it is not attended to it will accumulate very rapidly. This will, of course, reduce the coefficient of heat transfer and thereby the over-all boiler efficiency which in its final analysis will be reflected in higher costs of steam production. We have no difficulty in removing soot deposits when they appear.

Due to the erosive action of the tar flame, the brick work in the face of the bridgewall and sidewalls of the boiler suffer excessive wear. The life of the bricks is now prolonged by spraying them at intervals with hot patch cement, diluted so that it may be applied with a spray gun. This wrinkle probably has resulted in considerable saving.

This boiler is rated at 264 hp, but with the tar-burning equipment easily handles our entire plant requirements, developing at times over 400 hp.

A-C Wiring in Conduit

By C. O. von Damnenberg

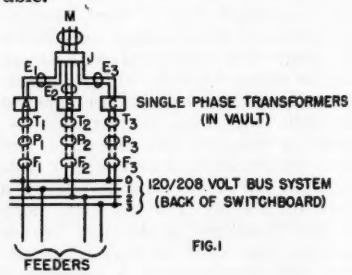
THE DETAILS given in a past issue, concerning the installation cables in conduit for 2-phase and 3-phase systems by Mr. E. G. Key, are always of value and can be re-read with profit.

There are also some similar applications including the same restricted methods which are of interest and well worth keeping in mind:

Fig. 1 shows a 3-phase feed to a vault, at 2400-v to transformers A, B and C by the way of terminal box "J" where the 3-conductor feed is split into three 2-conductor cables, one for each transformer, the bank of three units being connected in delta, the delta connection being made-up in terminal box "J." The low voltage system was star connected and instead of making it up at the transformers in the vault where the conditions were not desirable, each pair of conductors was carried from T_1, T_2 and T_3 to F_1, F_2 and F_3 through conduits P_1, P_2 and P_3, to a 3-phase, 4-wire bus system located at the feeder switchboard. This arrangement not only eliminated any bus connections in the vault but made possible the sealing of the conduit runs in the vault and at the switchboard; the bus system was readily accessible at the switchboard and made unnecessary any entry to the vault where the high voltage hazard was located. It is clear that six cables instead of three are required for the run between the vault and the switchboard but each is of smaller cross-section and the conduits are smaller, but in the aggregate the total cost was not materially greater and the final result was far more satisfactory in the actual operating experience.

Fig. 2 indicates a method where three underground conduits were actually installed and where the load conditions required a 3-phase feed of high capacity. Due to urgent needs of the situation the delivery of three 3-conductor cables could not be made in time so a single feeder cable and another cable of the same cross-section were pulled into each conduit; the ends of the extra cables called neutralizing cable 4, 5 and 6 in Fig. 2 were connected together and the system put into operation. This application is essentially the same in principle as a current transformer with the additional cable being the short-circuited secondary. It is clear that the current flowing in feeder cables 1, 2 and 3 sets up a field inducing a potential in the neutralizing conductors 4, 5 and 6 which causes a current to flow in them which in turn sets up a field opposed to the field set up by current in the main feeder cables 1, 2 and 3 and thus neutralizing its effect so there was no heating of the conduits and very little increased choking effect from the departure from 100 per cent neutralization as determined by actual test. While this method is not one to be universally applied it indicates how a difficult condition was overcome. It does indicate, however, a possibility and application when space is limited and large single conductor cables might be used instead of a number of 3-conductor cables.

Incidentally, the writer has carried as high as 100 amperes, a-c, 60 cycles with single cables through short steel sleeves where ventilation and heat radiating conditions were favorable.



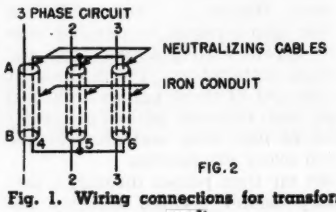


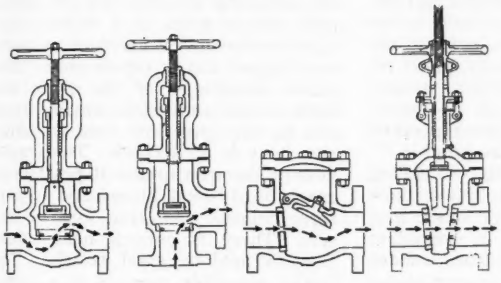
Fig. 1. Wiring connections for transformer vault

Fig. 2. Showing use of neutralizing conductors where single phase conductors are installed in iron conduit

How to Select, Install and Care for Valves

THE FIRST important consideration when specifying valves is to select the *right* valve. Long life, satisfactory performance and low maintenance depend upon fitting the valve to the job. Any user of valves, therefore, will do well to take seriously the following hints on the care and installation of valves prepared by the engineers of The Wm. Powell Co.

Whether a valve is suitable for a particular job is determined by its design and the materials of which it is made. There are four basic types of valves—Globe, Angle, Check, and Gate.



Globe **Angle** **Check** **Gate**

Arrows indicate line of flow

Fig. 1. Showing the four basic types of valves

The materials most commonly used in valve construction are Bronze, Iron and Steel. Valves for special service where they must be corrosion resistant are made of special alloys or of pure metals such as silver, nickel, etc. Among the commonly used alloys are stainless steel alloys, aluminum, aluminum bronze, acid bronzes, Monel metal, Inconel, Everdur, Herculoy, Chromium iron, and others.

To be sure of selecting the right valve and obtaining best results, it is necessary to know the kind of media and the amount of flow to be handled, the pressure, temperature, nature of service, the physical conditions at points where valves are to be installed and the frequency of operation.

Choosing the right metal means good service. Ordinarily bronze valves, in sizes up to 3 in. are suitable for steam pressures of 125 psi at 500 F, 150 psi at 500 F, 200 psi at 500 F, 300 psi at 550 F, and 350 psi at 550 F. Iron valves are suitable for steam pressures of 125 psi at 450 F, 175 psi at 450 F, and 250 psi at 450 F; while for higher pressures and temperatures steel valves should be used.

In processes where highly corrosive and erosive media are encountered only valves made of pure metal and special alloys should be considered. If there is any doubt as to what materials to use for best results, consult the manufacturers of the valves.

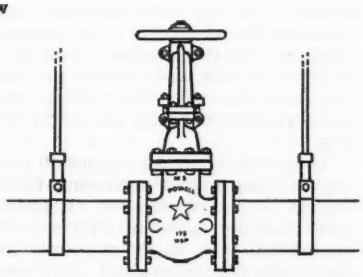


Fig. 3. It is good practice to support the line on each side of the valve

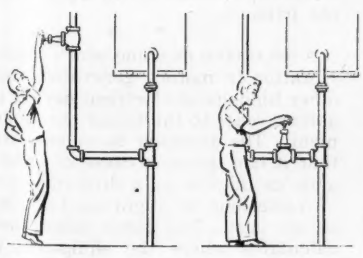


Fig. 2. Locate valves so they can be easily reached

When valves are to be stored before installation, keep them wrapped and protected as shipped by the manufacturer. If they are unprotected and left exposed, sand or other gritty matter may get into the working parts, and, if not thoroughly cleaned out will cause trouble later on. Also store valves so they cannot fall or where other heavy materials cannot fall upon them. Great care should always be exercised in handling valves.

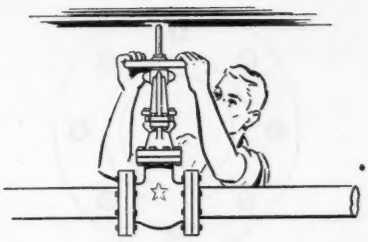


Fig. 4. Plenty of clearance must be provided so rising stem valves can be fully opened

Before installation the inside of the valves should be blown out with compressed air or flushed with water to remove all dirt and grit. Piping should be cleaned out in the same manner or it should be swabbed to remove dirt or metal chips left from threading operations on the pipe.

Valves should be conveniently located on the line so they can be easily and safely reached and so the operator can exert just the right amount of force to open or close them properly. When installed at fingertip height, rather than to get something to stand upon, the operator will usually try to stretch just enough to reach the hand wheel. In this position he cannot close the valve tightly and eventually leaks develop. While it is always better to install valves with the stem upright, they can be mounted in the line with the stem at any angle. However, when installed with the stem in a downward position, the bonnet is under the line of flow forming a pocket to catch and hold

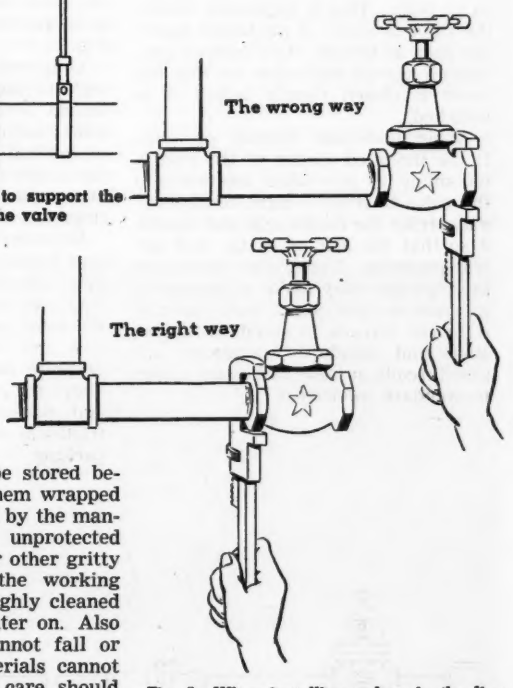


Fig. 5. When installing valves in the line always apply the wrench to the pipe line side

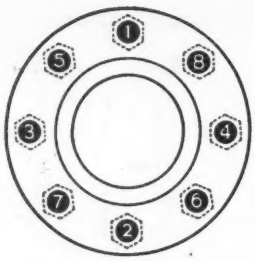


Fig. 6. Pull flange bolts in the order shown here

any foreign matter that will eventually cut and ruin the inside stem threads.

Keep pipe strains off valves. Don't let the valves carry the weight of the line. The distortion from this cause results in inefficient operation, jamming and early maintenance. It also makes it difficult to tighten the flanges properly. Piping should be suspended from hangers placed on each side of the valve to take up the weight.

When installing, rising steam valves, be sure to allow sufficient clearance to remove stem and bonnet if necessary. Insufficient clearance prevents valve from being fully opened and results in excessive pressure drop, gate bridge erosion, and chatter, wire drawing or seat wear.

When installing screwed end valves, always use the proper size wrenches with flat jaws (not pipe wrenches). By so doing there is less likelihood of the valve being distorted or damaged. Also the wrench should be used on the pipe side of the valve to minimize the chances of distorting the valve body. This is important where the valve is made of malleable material such as bronze. As a further precaution against distortion see that the valve is closed tightly before it is installed.

Avoid undersize threads on pipe. If the threaded section of the pipe is too small the pipe when screwed into the valve to make a tight connection, may strike the diaphragm and distort it so that the disc or wedge will not seat perfectly. Under size threads on the pipe also may make it impossible to make a tight joint. Safe practice is to cut threads to standard dimensions and standard tolerances. All pipe threads in valve bodies are gaged to standard tolerances.

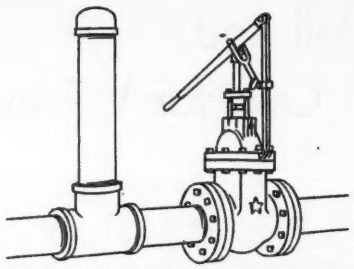


Fig. 7. A capped standpipe installed in the line in front of the valve eliminates water hammer

On flanger valves and fittings the flange bolts should be tightened by pulling down the nuts diametrically opposite each other and in the order as numbered, see Fig. 6. All bolts should be pulled down gradually to a uniform tightness. Uniform stress across the entire cross section of the flange eliminates a leaky gasket.

Paint, grease, or joint sealing compound should be applied only to the pipe (male) threads, not on the threads in the valve body. This reduces the chances of the paint, grease, or compound getting on the valve seat or other inner working parts of the valve to cause future trouble.

Where quick opening or closing valves are installed on liquid lines, severe water hammer or shock may result when the valve is opened or closed quickly. The resulting sudden back-lash or surge of pressure causes pounding and vibration in the line which eventually ruins the valve and weakens the pipe joints in the system. Usually a vertical capped stand pipe a few feet long and located not too far from the valve will tend to absorb the reverberating pressures, see Fig. 7.

Long runs of rigidly supported piping carrying high temperature fluids should be joined with an expansion joint having sufficient traverse to more than take up the expansion of the length of pipe involved. This kind of installation protects valves and fittings.

Frequently on large size high-pressure high-temperature steam lines or lines carrying hazardous media a U bent (see cut copy) in the line serves the same purpose.

A few drops of oil or oil and graphite now and then on the stem above the packing, will keep the stem and packing lubricated eliminating frictional wear between the stem and packing.

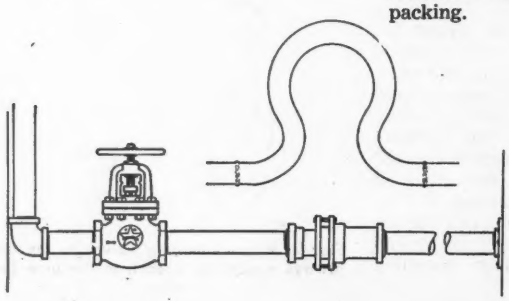


Fig. 8. A "U" expansion bend or expansion joint (below) relieves valves from all expansion and contraction strain

SHORTS

THE CATHODE RAY oscillograph is an electronic device that registers time too short for the human brain to conceive. It shows on the luminescent end of the tube what happens in as small an instant as 1/300,000,000 of one second.

* * *

IT IS WELL established that storage batteries may give as little as 25 per cent of normal output at sub-zero temperatures. To improve the efficiency in planes and other combat equipment subject to low temperatures the batteries are kept heated to about 70 deg F by means of a resistance wire grid installed between the batteries or built in.

* * *

A SMALL light-weight quick heating soldering iron for use in instrument repair work of a delicate nature, has been developed in an overseas Signal Corps repair shop. The main advantages of the irons are light-weight and quick heating. They can be brought from cold to effective heat in 45 seconds. The smallness of the iron makes it possible to reach hard-to-get places and to perform delicate soldering jobs in meters. There is enough heat retention to achieve good results. The heater assembly consists of a transformer having an output of 6 to 12 v with a current capacity of 10 to 30 amp. The power source can be 110 or 220 v, depending upon the transformer available. Two carbon electrodes are used and these can be obtained from a standard DA 30 flashlight cell. A suitable fuse is placed in the primary circuit of the transformer for protection of accidental shorting of the secondary. The basic principles of operation are that if the soldering iron is inserted between the carbon rods a current is permitted to flow in the secondary circuit. At the point of contact between the soldering iron tip and the carbon rod a high resistance contact results forming a small electric arc. The heat developed at these points of contact heats the iron.

* * *

A NEW surgical lamp expected to be a revolutionary help in operating rooms projects a cone of ultraviolet radiation through which germs cannot pass.

* * *

A BALANCING machine which checks vibration in motors, generators, and other high-speed electrical devices is adding years to the life of the equipment. The machine is so sensitive that it can detect a cause of unbalance as minute as a drop of water or vibrations as slight as 1/100,000 of an inch. The robot brain then calculates where the equipment is unbalanced and the amount of weight required to restore balance.

The Boiler Fireman's Handbook

By J. R. DARNELL

Single and multi-retort types of underfeed stokers . . . Air supply . . . Ash and clinker removal . . . Fuel bed temperatures and their relation to coal characteristics and ash fusion temperatures . . . How fireman should operate stoker to take them into account . . . Tempering coal . . . Starting the fire

Part XVI—Stoker Firing Methods (Cont'd Underfeed Types

UNDERFEED STOKERS in general may be divided into two main groups, namely, single and multi-retort types. Fig. 1 shows a plunger feed single-retort type while Fig. 2 illustrates the larger multi-retort type. The latter type always has plunger feed mechanism whereas the single retort type often is provided with a screen feed as shown in Fig. 3. Most single-retort types used for small boilers are less complicated and have considerably less moving parts than the multi-retort types.

Some multi-retort types combine the underfeed and overfeed principle of firing. This is shown in Fig. 4. In discussing the advantages of adding an overfeed section to an underfeed stoker the manufacturer of the stoker shown in Fig. 4 states:

"Without some provision for moving the ash and unburned fuel from the end of the underfeed section, there would be a tendency to adhere to the iron surfaces with subsequent formation of large clinkers. The slicing action of the alternating groups of fixed and moving overfeed grate bars located between the underfeed section and the ash pit prevents adhesion and provides a means for more complete burning out of combustible in the refuse before it is discharged. If clinkers form, they are advanced instead of remaining in one position. The stroke of alternate groups of bars is adjustable from the stoker front."

Another manufacturer also providing underfeed and overfeed sections, cools the grate bars by means of tubes connecting with the boiler circulation. In Fig. 5 are shown flow diagrams of the circulation with different types of boilers. These water cooling tubes are located directly above the grate bars and form the bottom of the combustion chamber. The coal feeding and adjusting mechanism is outside the furnace proper. The cooling tubes screen the secondary adjusting mechanism by creating what the manufacturer calls a "protective cold zone," thus solidifying molten and sticky ash into solid material before it reaches the air ports.

All modern design of underfeed stokers, whether single or multi-retort are provided with forced draft; the air being introduced at or near the point where the coal emerges from the retorts. Since incandescent burning fuel is at the top of the fuel bed and is replenished throughout the entire length of the retorts from beneath, as the coal approaches the surface, the volatile matter is distilled off and the coke which is formed becomes incandescent. Since the volatile gases are intimately mixed with air at the point where liberated, as the mixture passes upward through the incandescent coke, complete and smokeless combustion is effected without the use of ignition arches.

In such underfeed systems of combustion in which the excess air can be reduced to a minimum, high temperatures are produced in the fuel bed. Such temperatures usually are higher than the fusion point of the ash and clinkers necessarily must be formed. Recognizing the fact that clinker formation cannot be avoided with high combustion rates and low excess air, the manufacturers of underfeed stokers not only have provided means for advancing the clinkers, as previously described but have developed mechanism for either intermittent or continuous discharge of such clinkers and ash. Fig. 6 shows a dump grate for intermittent discharge. In Fig. 7 reciprocating extension grates supplied with low pressure air to burn out any carbon remaining in the ash. Ash and clinkers then fall into the double roll clinker grinders provided with adjustable crusher plates.

Fig. 8 shows a modification of the arrangement of Figures 6 and 7. Here the ash and clinkers are discharged over two sets of overfeed bars onto a dump grate or if a larger discharge area is required, this dump grate may be dropped.

Considerable data have been accumulated by various investigators relative to the comparative efficiency of clinker grinders and dump grates, the consensus of opinion being that clinker grinders are more efficient for a heavy load operating 24 hr per day.

Fuel Bed Temperatures

The successful operation of an underfeed stoker depends in a large measure, upon the relationship between the fuel bed temperature and the characteristics of the coal and the fusion temperature of the ash. Although, as previously mentioned, some clinkering is unavoidable if high combustion rates are maintained, since

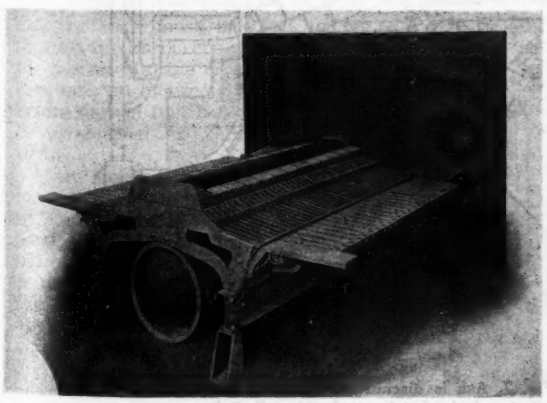


Fig. 1. Plunger feed single retort type of underfeed stoker

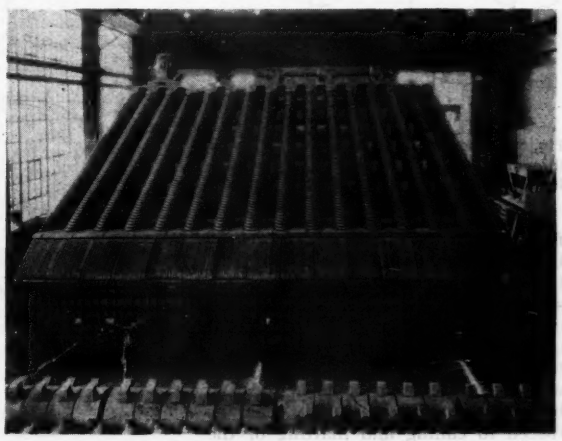


Fig. 2. This is a multi-retort type of underfeed stoker

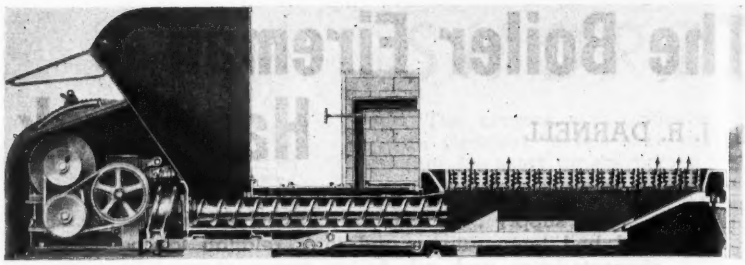
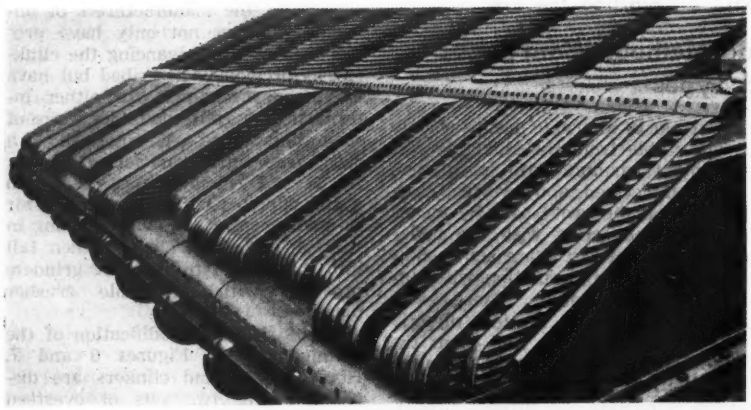


Fig. 3. (Right) Screw feed single retort type of underfeed stoker

Fig. 4. (Below) This multi-retort underfeed stoker has an overfeed section below the underfeed



sistance in the fuel bed to the normal flow of the coal down the retorts.

To remedy such conditions, the fireman should dump the ash grate or increase the speed of the clinker grinder, increase the movement of fuel down the overfeed section, lengthen the stroke of the secondary rams, and in some cases, shorten the stroke of the primary rams. These steps will cause a thinner fuel bed, widen the burning lanes and eliminates the hot spots without, in most cases, reducing the overall combustion rate. As a rule, Eastern coals require less travel on the grates than

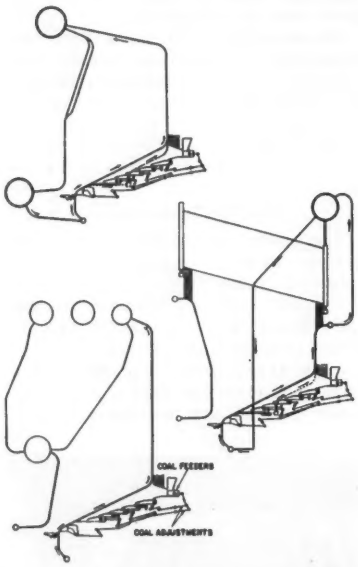


Fig. 5. These diagrams show the circulation through a water cooled multi-retort underfeed stoker with three different types of boilers

fuel bed temperatures are increased by an increase in the combustion rate, the fireman must be careful to avoid such a high temperature which will cause excessive clinkering or even cause melting of the grate bars. If there is uneven burning of the coal with excessively hot spots in the fuel bed, this condition usually can be traced to caking and matting of the coal and clinker formation. This, in turn, means that there is unusual re-

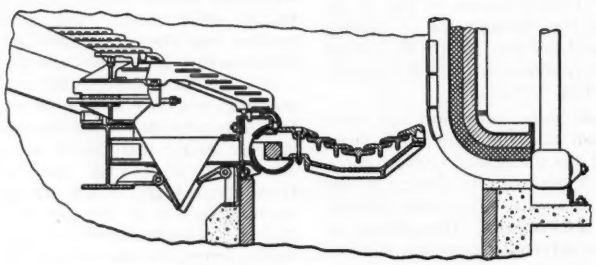


Fig. 6. This is a multi-retort underfeed stoker with an overfeed section and a single dump grate

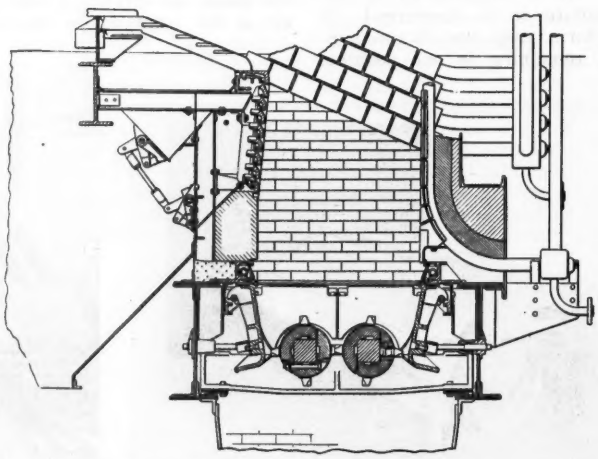


Fig. 7. Ash is discharged from this multi-retort underfeed stoker to double roll clinker grinders provided with adjustable crusher plates

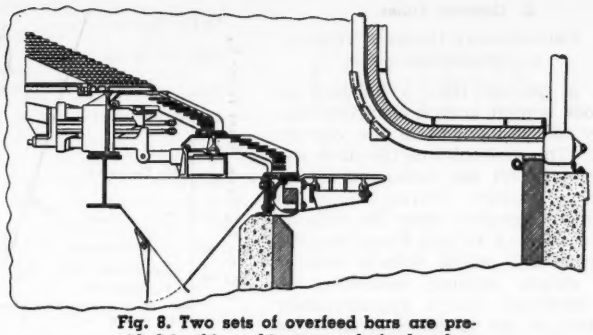


Fig. 8. Two sets of overfeed bars are provided in this multi-retort underfeed stoker, the ash being discharged from a single dump grate

the high-ash, high-volatile Western coals.

Tempering Coal

Many firemen and engineers believe that tempering coal for use in underfeed stokers is unnecessary, particularly where eastern coals are used. While it is true that tempering coal is not nearly so important with the underfeed stoker as compared to chain grate types, nevertheless, in some cases of underfeed stoker operation, conditions have occurred which led to the belief that uniform tempering would have given greater efficiency.

Starting the Fire

The hopper should be filled, the primary rams started and sufficient coal pushed in to cover the grates to a depth of about 4-in. If there is no power to operate the stoker, coal should be shoveled in by hand and evenly distributed over the grates. Next, throw in kindling and oily waste on top of the coal near the front wall. Light the fire across the entire front in order to provide even ignition. At first, open the breeching damper just enough to carry off the gas. Then, in a few minutes, turn on the forced draft fan and gradually open the blast gate or damper until the fuel is thoroughly ignited.

In starting a fire on stokers equipped with clinker grinders, the crusher pit should first be filled with ashes up to the bottom of the extension grates. If this is not done, extreme care must be used to see that all fuel is burned out before being pushed into the crusher pit and a long interval of time will be required before normal fuel bed conditions can be established and high loads carried.

If the stoker is taken off for inspection or repairs, the crusher pit should be emptied and repairs made to this portion of the stoker first, if such are necessary, without removing the ash from the retorts and tuyeres. Then the crusher aprons should be closed and the pit filled with the clinkers and the ash which were left in the retort and over the tuyeres. If this method is followed, the stoker can be fired up without delay.

Lubricants of the Future

AUTOMOTIVE ENGINE oils of the future will not have to be changed to lubricants of lower viscosity to ones of higher viscosity in summer. A recently tested new chemical additive of undisclosed composition is showing an ability so to lower the pour point of paraffin-base oil and at the same time to stabilize its natural viscosity that a single all-year-round luboil becomes practically a certainty.

The Fundamentals of Electron Tubes

Part IV Comparison of vacuum and gaseous tubes using thermionic emision . . . Effect of a small amount of gas in a vacuum tube . . . Principle of the two element gaseous tube . . . The thyratron or three element gaseous tube . . . The fluorescent lamp

By Ralph B. Immel

Control Engineer, Westinghouse Electric Corporation
East Pittsburgh, Pa.

A VERY SMALL quantity of gas in a vacuum tube will adversely affect the tube characteristics. The collision between the gas molecules and the electrons which are travelling from the cathode to the positive anode will liberate electrons from the gas and produce positive ions. The positive ions are then attracted to the negative cathode and may bombard it with sufficient force to impair and destroy the emission characteristics of an oxide coated cathode. A chemically active gas may also impair the cathode. The positive ions that are attracted to a negative grid will tend to decrease its control and considerably alter the voltage-current relationships of a vacuum tube. A tube with a gas pressure of 1/1,000,000 of an atmosphere will produce a luminous glow and the tube will be unsatisfactory for operation as a high-vacuum device.

However, the deliberate introduction of a suitable inert gas such as argon, helium, or neon into a tube at the proper pressure will produce characteristics greatly different from those obtained from the same tube with a high vacuum as a medium between the electrodes. The vapor of

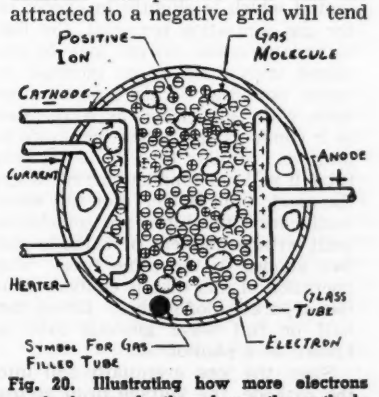


Fig. 20. Illustrating how more electrons reach the anode than leave the cathode when the tube is first operated

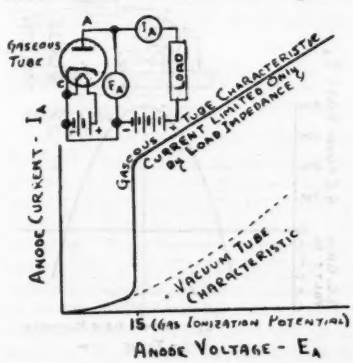


Fig. 21. Characteristics of a mercury-vapor diode compared to those of a vacuum diode

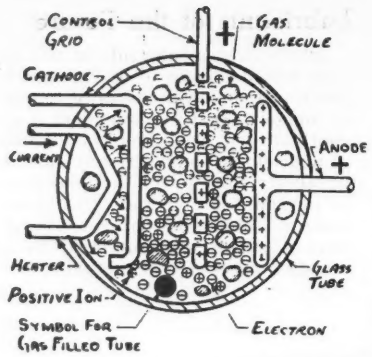


Fig. 22. This shows the three element gaseous tube with the grid and anode at proper positive potentials for conduction

some materials such as mercury or caesium are also quite commonly used in gaseous tubes. The gases previously mentioned are used when the ionization and deionization of a tube must be extremely rapid. The positive ions of these gases are much lighter than the metallic or mercury ions and have a higher transit velocity.

The main differences between a vacuum tube and a gaseous tube may be tabulated as follows:

The high vacuum tube has the characteristics of:

a. A large voltage drop from the cathode to the anode.
b. A high effective resistance from the cathode to the anode.
c. Requiring a relative high anode voltage to obtain a large anode current.
d. An energy transfer with a medium efficiency.

The gaseous tube has the characteristics of:

a. A small voltage drop from the cathode to the anode.
b. A low effective resistance from the cathode to the anode.
c. Requiring practically no change in anode voltage to obtain a high anode current.
d. An energy transfer with high efficiency.

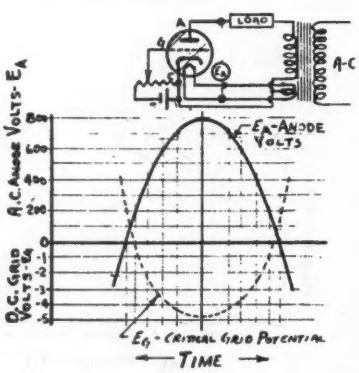


Fig. 23. Curve showing the critical grid potential of a three element gaseous tube

3. Gaseous Tubes

A. Two-element Gaseous Tube—Phanotron

In a gaseous tube a filament or cathode is used to emit electrons similarly to the element in the vaccum tube. The molecules of the inert gas completely fill the tube and as an electron usually travels with an enormous velocity from the cathode to the anode, it is very likely that the electron will collide with a heavier and slower moving molecule. A gas molecule moves approximately 1/600th as fast as an electron. The molecules are often struck by the electrons with such force that one or more electrons are knocked out of the molecule. The newly created electrons will travel toward the anode and may, in turn, set other electrons free and considerably increase the electron current during their transit to the anode. The molecule after losing an electron is no longer neutral and is known as a positive ion as it is positively charged. Figure 20 illustrates that more electrons reach the anode than leave the cathode when the tube is first operated.

These positively charged ions will be attracted by the negatively charged cathode and will neutralize the space charge between the electrons. This is accomplished as a positive space charge which is approximately equal in magnitude to the negative space charge, produced by the ions. The resultant space charge approaches zero and the current to the anode is limited only by the load impedance cathode. The gas in the tube may be completely ionized in approximately a microsecond and as the tube resistance is very low, a current flow of large magnitude may be accomplished almost instantly. The gaseous tubes utilize two electron emission methods; thermionic emission and ionization by collision.

The mercury vapor diode tube characteristics are compared to those of a vacuum tube in Fig. 21. At very low voltage as shown by Fig. 21, the anode current I_A increases with an increase in anode voltage E_A in the same manner as in a high vacuum tube. However, at some critical potential which is slightly in excess of the gas ionization potential, the full cathode emission current may be obtained with little or no increase in anode potential. This type of tube finds wide application as a rectifier as it conducts only when the anode is positive. Similar to a diode vacuum tube, it will not conduct current when the anode is negative. For full wave rectification the tubes are sometimes built with a filament or cathode and two anodes in the same tube. The operation of this tube is equivalent to two separate diode tubes. Either the half or full wave gaseous tube is known as a *phanotron.*

Since the ions eventually fall into the cathode, the voltage drop across the tube must be maintained below

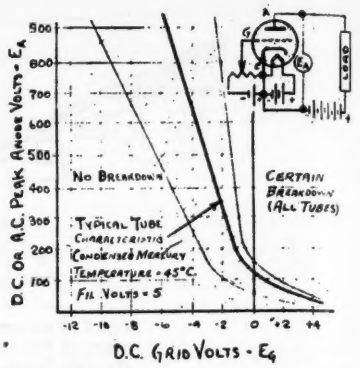

D.C. OR A.C. PEAK ANODE VOLTS - E_A
NO BREAKDOWN
CERTAIN BREAKDOWN (ALL TUBES)
TYPICAL TUBE CHARACTERISTIC CONDENSED MERCURY TEMPERATURE - 45°C.
FIL VOLTS - 5
LOAD
D.C. GRID VOLTS - E_G

Fig. 24. Set of curves for peak anode vs grid volts of a typical gaseous tube

a certain maximum and critical value or the voltage will accelerate the ions to a velocity high enough to disintegrate the cathode. The ionization potential of mercury is 10.4 volts and is the lowest voltage at which ionization will occur. The cathode is rapidly disintegrated and permanently damaged when the tube drop exceeds 22 volts. Tubes of this type are frequently operated with approximately 15 volts potential between the cathode and anode. At this and voltages less than 22 volts, the cathodes have a very long life.

Hot cathode mercury vapor tubes should always be operated within a definite temperature range as the temperature determines the mercury vapor pressure. When the pressure is too low (low operating temperature), the voltage required for complete ionization exceeds the voltage at which cathode disintegration occurs. When the pressure is too high (high operating temperature), the inverse voltage at which flash-back occurs is reduced considerably. The filament of a gaseous tube should be allowed to reach full operating temperature before the anode voltage is applied or the tube drop will exceed the cathode disintegration voltage and permanently damage the filament or cathode.

B. Three-element Gaseous Tube—Thyratron

The addition of a control grid to the previously described two element tube increases the versatility and application of the gaseous tube. The

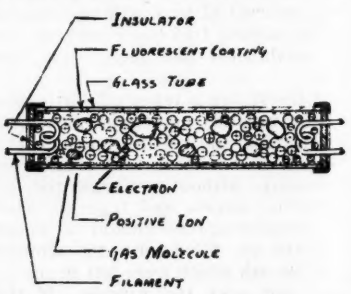


Fig. 25. Section of a fluorescent lamp showing principle of conduction

grid control in a gaseous tube is different from that of a triode vacuum tube in which the grid has complete control over the magnitude of the anode current at all times, while the grid in a gaseous tube performs only a trigger function. For a thyratron with positive anode, the grid is able *to initiate or start the current flow, but it cannot control the magnitude of the current or stop the current flow once that it has started.* The only way that the anode current can be interrupted is to reduce the anode voltage to a value below the gas ionization potential.

Figure 22 shows the three element gaseous tube conducting electrons when the anode and grid are at the proper positive potentials. As shown by Fig. 23, to prevent this tube from passing anode current or firing, on an alternating anode voltage E_A, the negative value of grid voltage must exceed E_g, the grid bias characteristics. Figure 24 shows a set of curves for the peak anode vs. grid volts of a typical tube. From Fig. 24 it may be observed that the tube will not fire or conduct anode current with 330 volts on the anode and the condensed mercury at a temperature of 45°C if the negative grid potential is at least 5 volts.

Application of the Thyratron Tube

This tube is widely used as a trigger device and in many industrial control applications it functions as a contactor or relay. With practically no energy in the grid control circuit, this tube can control enormous values of energy. Tubes of this type are commercially known as *thyratrons.* With d-c on the anode, the thyratron functions as a lock-in relay and with a-c on the anode it functions as a contactor or relay.

C. Principle of the Fluorescent Lamp

As shown by Fig. 25, a fluorescent lamp consists of a tube coated on the inside with fluorescent material and with a hot cathode at each end. Mercury vapor is formed in the tube when the filaments in each end of the tube are heated. After a suitable heating period, a high voltage is impressed momentarily between the filaments. This voltage will cause the mercury vapor in the tube to ionize and glow. After the voltage discharge has once started the glow, the glow may be sustained on normal line voltages. The inside of the tube is coated with a fluorescent material which will luminesce or give forth an extremely brilliant and efficient light when subjected to the ultraviolet rays of the mercury vapor glow discharge.

(To be continued)

The 17 million electric clocks in America run night and day for a nickel a month. This is because each clock uses only 2 watts.

LETTERS AND COMMENTS

A Good Engineer Steps Down

I was very much interested in the article in the May issue of Power Plant Engineering about Dan Gutleben who has been Chief Engineer of the Pennsylvania Sugar Refining Company for ever so long and who carried so many responsibilities on his shoulders. Mr. Gutleben certainly hung up a wonderful record in missing so few working days in all those years.

I never met this gentlemen and engineer but it would have been a pleasure for me to at least have made his acquaintance. I was always interested in his articles which appeared from time to time in Power Plant Engineering, but what I want to say here is that the first time I heard that Dan Gutleben was working in Philadelphia was when the Chief Engineer in the plant I was working at called one of his articles to my attention. This article was replete with good engineering as well as humor. The Chief always enjoyed articles of this kind and he always showed them to his men. On this particular occasion the Chief said, "Bill, you like to read good engineering, so when I come in to work tomorrow I will bring this article in for you to read."

I have read many of Dan Gutleben's articles since that time but to my mind that first article was one of the best, and I hope that Dan Gutleben in future years will find time to write about some of his past experiences. Even though he has stepped down from his position as Chief Engineer of Pennsylvania Sugar Company I hope that he doesn't step out of the picture so far as the technical magazines are concerned.

Lots of luck and a life of ease to an engineer who has done an outstanding job.

William T. Mullen

Determining Dia. of Gal. Steel Strands (A Correction)

In rereading my short article on p. 101 of the June issue of Power Plant Engineering, "Determining Overall Diameter of Galvanized Steel Strands," I discovered a mathematical error. I then checked back on my work and it was correct; then checked the manuscript sent to you and found that I had there made the error.

In the solution to equation (4), third column, page 101, the mathematical work should be as follows:

$\sqrt{83{,}690(C - 0.1111)} = 360$

$83{,}690(C - 0.1111) = 360^2$

$83{,}690C - 9{,}298 = 129{,}600$

$C = 138{,}898/83{,}690 = 1.6597$, from which

$(C - 1/3N) = 1.6597 - 0.111 =$ 1.5486 as in (1).

This is purely the result of not checking the values as taken from the original work, and I assume the entire responsibility for the error. Fortunately equations (1), (2) and (3), are correct as published, so that no error would have resulted from their use.

I trust that correcting the error will not cause you any undue inconvenience.

Raleigh, N. C. F. C. DeWeese

Deer, Deer, What a Problem?

Editor's Note: Some time ago Brother Parker, the poetic chief engineer of the Peterborough Hospital up at Peterborough, N. H., sent us the following request for aid. As will be noted, Bro. Parker knows his onions when it comes to flattery and being human the editor tried his best to be of service. After all, it was a comparatively simple problem or at least so the editor thought, and he went at considerable length to explain to Bro. Parker the principle

and merits of the electric fence. These fences, he pointed out to Mr. Parker, were widely used by farmers throughout the country and were very effective in keeping live stock where it belonged. As a matter of fact, he even referred the chief at Peterborough to the Sears-Roebuck catalog and suggested he order an electric fence right away. By so doing all Bro. Parker's troubles would vanish at once—so the editor thought. Well, from here on, follow the story as it unfolds.

Hi, there, Andy, electric wizard,
Who knows your stuff from A to Izzard,
Greetings, Andy, electric champ,
Familiar with each volt and amp.

Old Pal Parker—that darn bore,
He's got to have advice once more.
That tender heart pray do not harden,
But help us with our Victory Garden.
(A little poetic license here.)

Our Victory plot is hard to beat,
It's full of splendid things to eat.
Beans and peas and spinach, too,
Good for us and good for you.

There's corn and chard and cukes so fine,
Kentucky Wonders on the vine,
High voltage onions—oh, my Gosh!
Tender, golden summer squash.

It's great to have these things to eat,
Such vegetable would be a treat.
They would be, sure, but we don't eat 'em.
Who does? The deer—and we can't beat 'em.

Tin cans swinging in the breeze,
Ammonia to make them sneeze,
A sweaty shirt for them to sniff;
Nothing makes to them no diff.

They're glad, it seems, to take a chance
With the C. E.'s ragged shirt and pants.
There on a pole with straw stuffed hat,
Do they give a damn for that?

They don't. At early morn
They trample down the rustling corn,
Breakfast on our dinner greens
And reconnoiter in the beans.

The peas we longed for—where are they?
Gone like the snows of yesterday (Last winter's, I mean),
Gone the vines for yards and rods,
Gone the vines and peas and pods.

Mr. Kramer—help us out,
You always know your way about.
In other ways we just can't knock 'em,
How would it work, suppose, to shock 'em?

That crowded space between your ears
Has helped me out for years and years.
I'm sure there's information there
That you, with me, will gladly share.
What—for this lingos my excuse
I want to give those pests some "juice."
Would it work, and how to do it?
Thanks for the help Andy—you would I knew it.

ARTHUR H. PARKER.

A few days after we had told Bro. Parker all about the electric fence, we received the following letter from him. It seems our suggestion of the electric fence was not so hot.

Dear Mr. K.:

Some time ago, I received a letter from Mr. C. F. Jackson, Director of the Biological Institute of New Hampshire at the State University. At my request he had made an intensive study of the reactions of deer to electric fences. The fence shocks them but unlike the reaction in domestic animals, the shock tends to make them jump *ahead* and through or over the fence. Consequently, as things stand my plan to keep them out electrically is worse than n.g.

Yesterday, I viewed with anger and dismay the hollowed out shell of a huge pumpkin, our only one, completely surrounded by the cloven hoof prints of the pesky deer. How I had looked forward to the delicious pies to be sired by that great, glowing juicy globe of delight!

Do you like pumpkin pie? If so, maybe, now, you will help me find a way to keep the pesky deer out of our garden.

ARTHUR PARKER.

Well, there it is. We are back where we started. The electric fence instead of driving the deer away it seems projects him right smack into Bro. Parker's vegetable patch. As he points out in his poetry, he has tried a number of things, including tin cans swinging in the breeze. Of course, he could build a twelve foot wall or fence around the garden but it is evident that the economics of the situation do not permit that. What have you to offer? Let's have your suggestions.

Turbines Still Explode

RECENTLY we shut down for our annual inspection and cleaning of turbines and other equipment. We have been in the habit of doing this work every year for the past 20 years. This work is, of course, supervised by the manufacturer's service engineer. At the same time the insurance inspector checks over the equipment and tests or "megs" the rotor, exciter, fields, etc., of the electrical end of the machines.

For some reason the electrical end megged too low. As the machine had then been down for three days and the weather was damp, the first thought was that the windings, or supporting insulation had absorbed moisture.

Consequently the insurance inspectors decided to come back for a recheck after the machine had been on the bus for a week and see how it megged after a week's run. They came on a Saturday morning after we shut down at the week-end shut down period. After the recheck of the machines it was found that they still megged low. After the leads to the oil circuit breaker were unhooked and the equipment remegged ge got a satisfactory reading of 20+.

The reason the inspectors were in such a state of alarm, I found out was that they lost three turbines during the two preceding months.

In our case the trouble was only a grounded bank of meters and so as far as the inspectors were concerned they went back satisfied.

This brings to my attention a case where a power plant operator of my acquaintance lost his life in a local plant just a short time ago. This machine had been taken apart for the annual inspection and everything was in fine shape. It was then placed back into service and after being in service for a couple of weeks it blew up.

Of course, the usual investigations followed and after a careful study to determine the cause of the explosion, it was found that a nut had worked loose on a composition disc valve from the steam line, and got under the throttle of the turbine.

Apparently when the engineer started up the turbine at no load, the machine oversped. The overspeed trip mechanism tripped the throttle but the valve did not seat due to the foreign body lodged in the valve seat, with the result that the turbine had enough steam admitted to create a centrifugal force strong enough to throw the blading off the spindle through the turbine casing.

Somebody at one time, through lack of foresight or complete ignorance, had installed a valve on the steam line that was not designed or recommended for that particular kind of service.

Had the person responsible for this condition known his business he would have used a valve designed with a steel disc and with lock nut over the disc and not under it as it was in this case.

I had an experience some time ago which was not dangerous but had its possibilities of creating trouble. I took apart an atomospheric relief valve for cleaning and inspection and there lying on the seat ledge of the valve casting was a ½ in. nut. It was dropped there accidently or carelessly at one time or another. Had the valve been opened up automatically during this time the nut would have slipped under the valve disc and would have kept the valve open. Fortunately it was removed before any mechanical complications developed.

I strongly urge other engineers to permit no one but a qualified person to work on steam lines leading to and from prime movers such as turbines or engines. The hourly rate of pay may be a little higher than the usual jack of all trades get but it is well worth the cost to know that everything is under proper control.

JOHN F. SLAVINSKY.

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Fig. 2125 Bronze Gate

Fig. 16 "Renewo Globe"

Fig. 1430 Iron Body Gate

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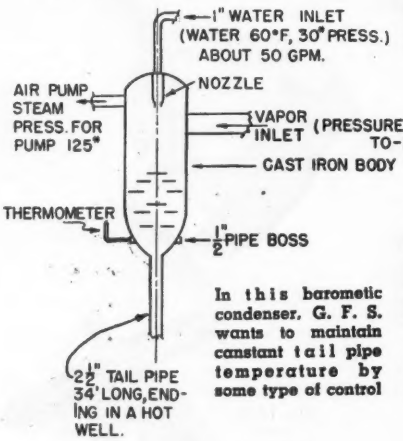
Questions And Answers

Question No. 311

How Maintain Constant Temperature in Barometric Condenser Tail Pipe?

ON THE BAROMETRIC condenser shown in the sketch, we would like to control the inlet water with a simple device so as to maintain an even tail pipe temperature (preferably 90 F).

Room inside the cast-iron body is very limited. The space in the condenser or tail pipe cannot be restricted much. High sensitivity is required—tolerance about 5 F.



In this barometic condenser, G. F. S. wants to maintain constant tail pipe temperature by some type of control

It is preferable to use a regulator not requiring air pressure. Winding a thermotube around the tail pipe does not seem to be sensitive enough. In a previous attempt a reverse acting valve was used with a thermotube 18 ft long. This tube was inserted in the tail pipe. Since at 29-in. vacuum the tail pipe remains nearly full of water, the temperature changes at the thermometer were not followed rapidly enough in the body of water in the pipe to affect the thermotube as desired.

Waukesha, Wis. G. F. S.

Question No. 312

What Happens When Air and Moisture Meet?

ACCORDING TO THE text books on engineering, one pound of standard air at 70 F dry bulb and 70 F wet bulb is equal to 13.34 cu ft in volume at 29.92 in. barometric pressure. At 70 F, one cubic foot will hold 8.23 grains of moisture; 13.34 cu ft will hold 8.23 times that, which is 110 grains of moisture.

Now we realize that water is heavier than air; that being the case, where is the 6890 grains that make up the pound? We all know that there are 7000 grains in a pound, and there are 437.5 grains in an ounce; 110 grains are about one-quaretr of an ounce. What makes up the other 15¾ oz. or 6890 grains? I would appreciate very much if you would send me an analysis of this problem.

Providence, R. I. H. H. L.

Question No. 313

Can This Boiler Be Changed to Give Dryer Steam?

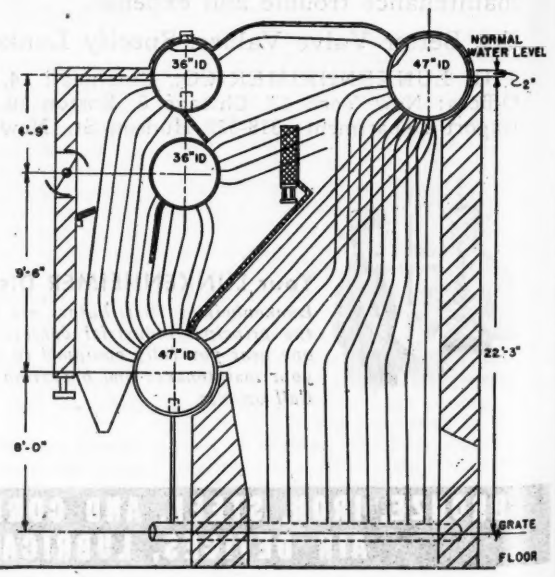
CAN THE BOILER shown in the sketch be changed so that, instead of delivering 85 per cent dry saturated steam as at present, it will deliver 98 per cent dry saturated steam?

The boiler has 4600 sq ft of surface in the tubes plus 320 sq ft of side wall surface plus 15 sq ft of side wall header surface—total 4935 sq ft. Furnace volume is 1350 cu ft.

The boiler is equipped with a thermostatic type water level controller. The water level is carried 2 in. above the center line of the front drum and the level varies 4 in. in the glass. The feedwater is treated by the lime-soda process. Make up is 45 per cent.

The boiler operates at 130 psi gage and at times must deliver as much as 30,000 lb of steam per hr. This steam is supplied for evaporators, process uses and for a Corliss engine supply requiring no superheat.

Chicago, Ill. E. O. D.



Cross-section of E. O. D.'s boiler, from which he wants to obtain 98% dry steam instead of 85%. Each tube line in the drawing represents one tube

Answer No. 295

How Should These 2 Boiler Plants Be Operated?

QUOTH P. E. R. in the May issue:

We have a straight pipe line 4000 ft long and a boiler plant at each end of the line, as shown on the sketch.

The industrial plant demand is 5000 bhp and the main line pressure is 125-psi.

Now let us assume that Plant No. 2 is generating its full 5000 hp. At the boiler end of the line we have 125 psi and we experience a 35-lb pressure drop at the far end. This pressure drop does not affect the process or heating load.

With these conditions existing, let us fire up Plant No. 1 and supply 1000 hp to the main header. This question then arises:

How much load will be dropped at Plant No. 2? Or, to put it the other way, how much load will Plant No. 2 have to carry now?

How will the velocities be affected?

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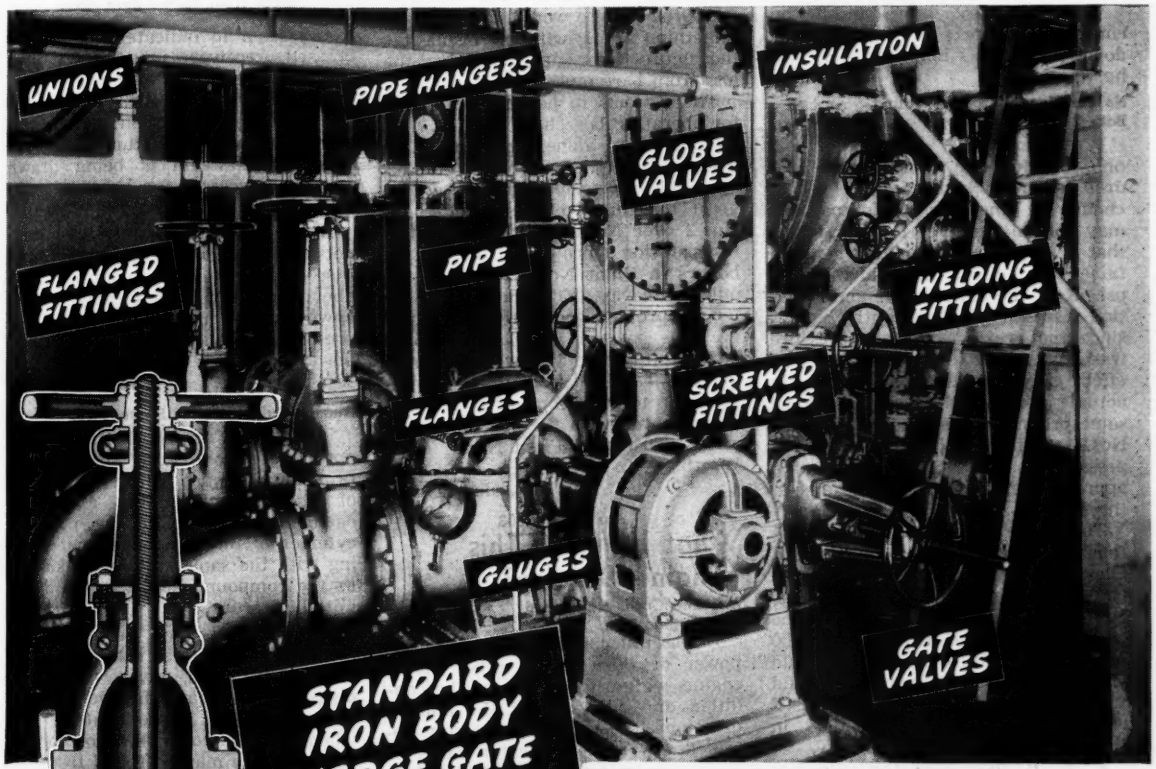
Condenser and circulating water pumps in power plant



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	Saturated Steam	Cold Water, Oil or Gas, Non-Shock	Cold Water or Gas Non-Shock
2 to 12 in.	125 pounds	200 pounds	200 pounds
14 and 16 in.	125 pounds	150 pounds	150 pounds
18 to 24 in.	*	150 pounds	150 pounds

*For steam lines larger than 16 in., Crane 150-Pound Cast Steel Gate Valves are recommended. (For sizes under 2 in., use Crane Clamp Gate Valves.)

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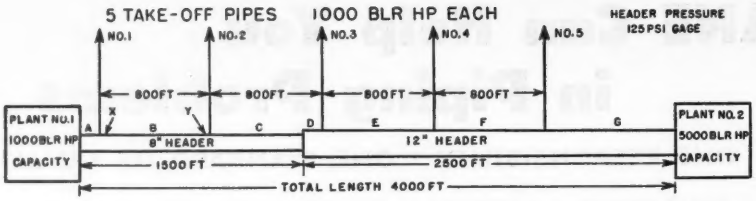


Diagram showing arrangement of P.E.R.'s boiler plants and steam distribution system to illustrate answer by Alfred F. Fox

How will the condensation rate be affected?

Discounting operating labor and any difference in efficiency rate of equipment, would we be justified in operating both boiler plants and to what extent?

With the entire plant load off, the condensation rate during a shut down period was approximately 200 hp.

No Justification for Operating Both Plants, Says Fox

WITH PLANT No. 1 generating 1000 bhp, the load on Plant No. 2 will drop to 4000 bhp, if there is no change in line loss. This may, or may not, be the case. P. E. R. states that the pressure would be maintained throughout the header at 125 psi. If so, the temperature and radiation losses would be slightly higher, since the previous average pressure was 125 minus 35/2 = 107.5 psi. This effect may be discounted, since, in actual practice, there will still be some pressure drop; and both Plants Nos. 1 and 2 would be operated at pressures below 125 psi to maintain approximately the same pressures at the loads as existed previously.

The only real saving in line radiation losses would lie in shutting off Section B by closure of valves located at X and Y, as shown in the accompanying diagram. Assuming the correctness of P. E. R.'s figure of 200 bhp for the entire line, this would amount to 30 bhp. Even this would scarcely make up for the increased radiation loss from the boilers in Plant No. 1.

P. E. R. asks how the velocities will be affected. Obviously, they will be in the following ratios, compared with those which previously existed, namely, B - O, C - ½, D - ½, E - ⅝, F - ¾, and G - 4/5, or, in feet per minute, C - 5110, D - 2190, E - 4380, F - 6570, and G - 8760.

Pressure drops have been calculated and were found to be approximately 48 lb up to take-off No. 1 with Plant No. 2 operating alone, and 21 lb up to take-off No. 2 with both Plants operating. If these theoretical figures are scaled down to conform with the 35-lb drop experienced in actual operation, it is evident that with both Plants operating, No. 2 may be run at about 105 psi and No. 1 at 90 psi to obtain equivalent results at the load.

Similarly, radiation losses were calculated, assuming 2-in., 85 per cent magnesia covering. Losses in the 4000-ft header should total between 25 and 30 bhp. Is it possible that P. E. R.'s figure of 200 bhp includes auxiliaries, or that it was obtained during a cold start up? If the actual loss on the line amounts to 200 bhp, there would appear to be something wrong with the insulation, the figure given approximating the loss from bare pipe.

There seems to be no justification for operating both boiler plants. Additional labor, alone, would probably prove to be the controlling factor. It would be expected that only a very great margin of efficiency of Plant No. 2 over No. 1 could ever justify its operation, since part, if not all the boilers in Plant No. 2 would be required anyway. Efficiency might enter the problem indirectly only, since the true basis of comparison would be the difference in cost of generating the last 1000 bhp, that is, from 4000 bhp to 5000 bhp in Plant No. 2, as compared with the cost of generating 1000 bhp in Plant No. 1.

Westbury, L. I., N. Y.

ALFRED W. FOX

Answer No. 303

What Hp Will This Engine Develop?

Indicator Cards Developed from Engine Data

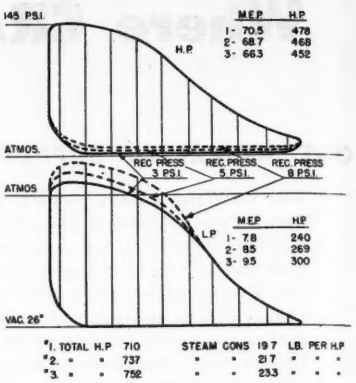
BEFORE ONE can calculate the horsepower of this or any other steam engine, we must get data on the condition and efficiency of the unit in question. This can only be truly obtained by taking indicator cards or by dynamometer test and this, compared with the steam consumption will give us the desired answer.

In this case, where we have the details of the engine size, speed, and pressure we can draw a set of cards to scale and, assuming the engine to be in good condition, we then get the data as shown on the accompanying cards.

Assuming the cut-off in both cylinders to be about one-half stroke, the cards should show an mep as indicated.

In case 1, the high-pressure cylinder develops 478 hp, almost twice the power of the low pressure, which is 240 hp, whereas in case 3 the horsepower of each cylinder comes much closer to being equal.

However, the steam consumption per horsepower in case 1 is only 19.7 lb but in case 3 it is 23.3 lb. This



Indicator diagrams drawn by George McNally from engine data given

would seem to indicate that the increased receiver pressure, though tending to balance the power developed by either cylinder, also raises the steam consumption per horsepower, which fact in turn would indicate that steam is being drawn from the receiver for heating, process or other work.

If this is so, then that steam cannot be charged to engine consumption which is now apparently far above normal. It is clearly shown, however, that increasing the receiver pressure tends to balance the horsepower developed by each cylinder.

Kearny, N. J. GEO. MCNALLY

Hudson Calculates the Horsepower

IT HAS BEEN STATED that the horsepower of a compound engine is approximately equal to the horsepower of a single engine having a cylinder equal in volume to the low pressure cylinder of the compound and working with the same ratio of expansion as the compound and with the same initial pressure.

The problem, then, resolves itself into finding the total ratio of expansion from which, given the initial pressure, the mean effective pressure may be found approximately, and when this is known, the horsepower of the engine may be found from the familiar formula HP = PLAN ÷ 33,000. The ratio of expansion in any engine is equivalent to the ratio between the volume of steam in the cylinder at cut-off and the volume of steam in the cylinder at point of release to atmosphere or condenser; the same holds true between the high and low pressure cylinders of a compound engine.

In Case 1, the given steam consumption is 14,000 lb per hr or 14,000 ÷ 60 = 233.33 lb per min. Since the speed is 74 rpm or 148 strokes per minute the steam consumed per stroke is 233.33 ÷ 148 = 1.5765 lb.

The given pressure is 145 lb gage or 159.7 per sq in absolute and the volume of steam at this pressure is 2.839 cu ft per pound.

The volume of steam in the high-pressure cylinder at point of cut-off

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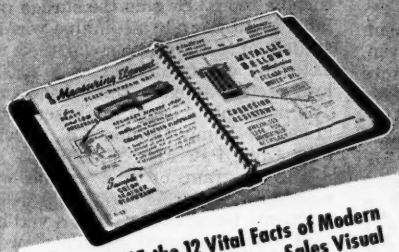

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then becomes 1.5765 lb x 2.839 cu ft per lb = 4.4756 cu ft.

The low pressure cylinder diameter is given as 42 in. Its area is 1385.45 sq in. or 1385.45 ÷ 144 = 9.62 sq ft and the volume swept through by the piston each stroke will be 9.62 x 4 ft (length of stroke) = 38.48 cu ft.

Assuming the clearance volume of the low-pressure cylinder to be 5 per cent of volume swept by the stroke, the total volume of the low-pressure cylinder will be 38.48 x 1.05 = 40.404 cu ft.

Exhaust valve opening and consequent release of steam from the cylinder to the condenser will be assumed to be 11/12 of the stroke and the volume of steam in low-pressure cylinder at release will then be 40.404 ÷ 12) x 11 = 37.037 cu ft. The total expansions will be 37.037 ÷ 4.4756 = 8.27. Kent's handbook gives ratio of mean pressure to initial pressure 0.3849 for 8 expansions and 0.3552 for 9 expansions.

Interpolating the difference we find that 8.27 expansions gives a ratio of mean to initial pressure of 0.3769.

With an initial pressure 159.7 lb per sq in., the mean forward pressure on the piston will be 159.7 x 0.3769 = 60.19 lb per sq in. absolute.

With a 26-in. vacuum, the mean back pressure will be 1.93 lb per sq in. absolute. Subtracting this from the mean forward pressure gives a mean effective pressure of 58.26 lb per sq in. absolute.

A 4-ft stroke at 74 rpm gives a piston speed of 592 ft per min. In the familiar formula HP = PLAN ÷ 33000 or HP = P x (LAN ÷ 33000) in which LN = the piston speed and A = piston area in sq in., and then LAN ÷ 33000 gives a constant by which the mean effective pressure is multiplied to give the horsepower. Substituting the proper values the constant for this problem becomes (4 × 1385.45 × 148) ÷ 33000 = 24.854 and the horsepower developed will be 24.854 × the M.E.P.

The horsepower developed under Case 1 then becomes 24,854 × 58.26 = 1448.

Case 2 is solved in a similar manner with the steam consumption increased to 16000 lb per hr. The volume of steam in the high-pressure cylinder at cut-off will be [16000 ÷ (60 × 148)] × 2.839 = 5.1139 cu ft.

The ratio of expansion will be 37.037 ÷ 5.1139 = 7.24. The ratio of mean to initial pressure for 8 expansions is 0.3849 and for 7 expansions 0.421.

Interpolating the difference, the ratio of mean to initial pressure for 7.24 expansions is found to be 0.413 and the mean absolute forward pressure for this value will be 159.7 × 0.413 = 65.956 lb absolute.

Subtracting the mean back pressure of 1.93 lb per sq in. gives an absolute mean effective pressure of 64.026 lb per sq in. for Case 2 and the horsepower developed = 24.854 × 64.026 lb = 1591 hp.

In Case 3, the volume of steam in the high pressure cylinder at cut off will be [18,000 ÷ (60 × 148)] × 2.839 = 5.7546 cu ft and the ratio of expansion will be 37.037 ÷ 5.7546 = 6.436.

The ratio of mean to initial pressure for 6 expansions is 0.4653 and for 7 it is 0.421. Interpolating, the difference gives a ratio of 0.446 for 6.436 expansions. The mean forward pressure for Case 3 is 159.7 × 0.446 = 69.296 lb per sq in. absolute. The mean effective pressure = 69.296 — 1.93 = 67.366.

Since the constant remains the same, the horsepower developed under Case 3 is 67.366 × 24.854 = 1674 hp.

It is admitted that this method of computation gives results somewhat higher than the engine will actually develop under the conditions given and furthermore assumes no steam leakage through valves, piston rings, etc. However, from the data given some assumptions must be made, hence any result will be more or less approximate.

It will be noted that the variable receiver pressures given have not been used in the computation. The energy utilized in any quantity of steam by any engine depends upon the range of pressure, and, therefore, temperature through which the expansion takes place regardless of the number of cylinders through which the expansion takes place. Since the steam consumption in the problem is given, consideration of the receiver pressure is unnecessary. Varying the receiver pressure may, however, change the steam consumption of a compound engine for any given load.

Any change in receiver pressure which results in a shorter cut-off in the high-pressure cylinder for any given load, without causing the expansion line in the high-pressure indicator card to drop below the exhaust line, will bring about a corresponding reduction in the steam consumption for that load. This is so because less steam per stroke is drawn from the line and, since the volume of steam exhausted to the condenser is fixed by the point at which the exhaust valve opens in the low-pressure cylinder, which is constant, the ratio between this volume and the volume in the high pressure cylinder at cut-off is increased; more expansions of steam take place; and consequently more work per pound of steam is done.

Plymouth, Mass. C. BROOKS HUDSON

Answer No. 304

How About a Corliss with Three Eccentrics?

"WHAT CAN YOU TELL ME about a single Corliss engine with three eccentrics?" was a question recently fired at one of E. C.'s men during a license examination.

Fred Gould, in the October issue, explained how and why the Nordberg long-range cut-off engine employed three eccentrics. Many engineers have also seen a 3-eccentric Corliss driving a circulating or air pump used with condensers on old types of turbines, especially the old vertical machines. Comments on these are given below.

Three Eccentrics Use on Circulating and Air Pump

A CORLISS engine unit that performs the functions of circulating and air pump on an old vertical type turbo-generator has three eccentrics. The pump unit is vertical and has an "air" cylinder beneath the steam cylinder. The common piston rod extends from the bottom of this lower cylinder to the crosshead as in any conventional steam engine. The main shaft of this engine drives the circulating pump. The two additional eccentrics on the main shaft operate the suction and exhaust valves of the "air" cylinder. They are located on opposite sides of the crank just outside the main bearings.

FREDERICK A. HIPPLE
Philadelphia, Pa.

Here's One for the Old-Timers

THIS IS ONE for the old timers. We asked Bill, the old-timer operator and mechanic at the generating station about the 3-eccentric Corliss in the turbine room. He said the station was built in 1912, and this engine was installed at that time as part of the assembly of auxiliaries for a 20,000-kw vertical steam turbo-generator. The name plate bears this inscription, "Laidlaw Dunn Gordon Co., Cincinnati, Ohio, Pat. Feb. 26, 1907."

The diagram of this engine was made from sketches, no actual measurements being taken. It is a vertical view. The original sketches were made from the turbine room crane, 65 ft above the engine.

The circulating water pump is connected to main drive shaft of the engine with a solid coupling. This engine not only has 3 eccentrics, but also 3 stuffing boxes on the piston rod. Behind the steam cylinder is a second cylinder that pumps the air out of the vapor side of the condenser. The vacuum comes up to 26-in. in 5 min.

This engine has a rotative speed of 110 rpm, is single steam cylinder, non-condensing, and the valve gear is non-releasing.

Governing is effected by a loaded pendulum governor, which controls a double-flow throttling valve in the steam header leading to the steam chest. The governor is belt driven from the main shaft. The pressure volume diagrams obtained by the use of an indicator are identical in shape, as the piston rod passes through the cylinder on both sides of the piston.

The first eccentric, the one nearest the flywheel, operates the valves on the air pump. The middle eccentric operates the wrist plate, to which are connected the steam admission

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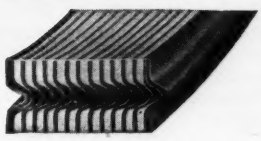
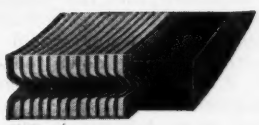


AJAX Spiral Wound



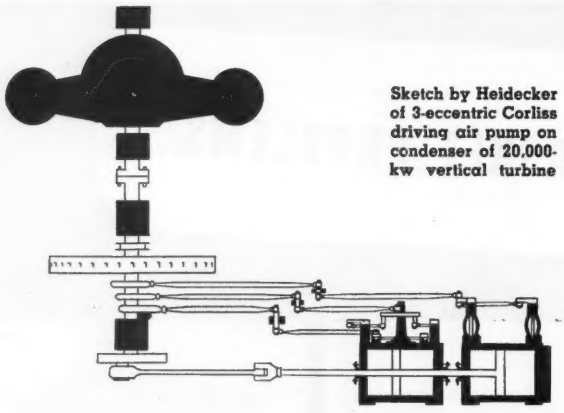
AJAX S-R Spiral Wound

Oval Solid Metal Ring Type

Single Jacket Metal-Asbestos

Double Jacket Metal-Asbestos

Octagonal Solid Metal Ring Type



Sketch by Heidecker of 3-eccentric Corliss driving air pump on condenser of 20,000-kw vertical turbine

valves on the top of the cylinder. The third eccentric operates the exhaust valves located on the bottom of the steam cylinder.

The eccentric straps are connected to rockers with eccentric rods. The rockers are connected to the valve gear with reach rods.

There is a lot of bright meatal that requires the generous use of elbow grease, emery cloth, and metal polish. The part we liked most was the whistle. Pulling the whistle cord brought the watch engineer into the turbine room shouting, "Whoinell is blowing that G—— D—— whistle again !!!" He said some other things, too, but we do not think Mr. Kramer would print them.

Chicago, Ill. WALTER HEIDECKER

Answer No. 305

How Control Village Water System from Pressure?

SOMEBODY told the village council it couldn't be done because a peak demand for water would pull the system pressure down too low. But F. J. H., who asked about it and diagrammed the system in the August issue, believes it can be done. So do other engineers, who tell him below how they would go about it.

How Can It Be Done with Pressure Switches

THIS PROBLEM is a common one; however, it is relatively easy and inexpensive to correct. Fortunately F. J. H. has a large line and low flow, so that, by assuming a flow of 50 gpm, and a C factor of 100 for cast iron pipe (no allowance for fittings) he has a pressure loss from pumps to tank of 1 + lb, which will allow fairly close level control in the storage tank.

He should leave the pumps connected as he has shown, but install a check valve and rising stem gate valve in the discharge line of each pump. Install a ¾-in. connection in the main 6-in. line and run a line to a panel board near the pumps. Purchase 2 narrow-range Mercoid on-and-off pressure switches and 2 Ray or equal pressure snubbers and install the snubbers directly under the Mercoid switches. The Mercoid switches are connected electrically to the pump starters. Operate the pumps individually and set the pressure on-and-off points to correspond to the desired high and low levels of the storage tank.

A foot valve must be installed on the pump with the suction lift; it would be good insurance to install one on each pump. It will not be possible to operate the pumps together, for the pump with the suction lift will not have the same discharge pressure as the other one and will therefore run under it. If F. J. H. consults the pump manufacturer they can furnish him with impellers so that the pumps can be operated together. If the town uses water in large enough quantities to cause a high pressure drop in the line from the storage tank to the pumps, then one of the pumps will start up and stay on the line until the tank has reached its high level.

The above system is working very well in one small town that I know of and I see no reason why it will not work for F. J. H.

Port Neches, Tex. P. N. HUNT.

Details of Pressure Controls from Webber

THE PROBLEM presented by F. J. H. can, I think, be worked out as he desires in spite of the advice to the contrary. I do not think it would be necessary to run a separate line between the wells and tank for taking into consideration the size of the system, the main is of ample size to prevent an excessive drop in pressure under anything near normal operating conditions.

As a protection to the pumps against low water in the wells, I would suggest a float control as per Fig. 1. The float should be adjusted to shut the pump down before the water level is low enough to endanger the pump. When the water reaches somewhere near normal height, the float should again close the switch to put the pump back in service.

Regarding the automatic control of the pumps I think a diaphragm pressure control would answer the

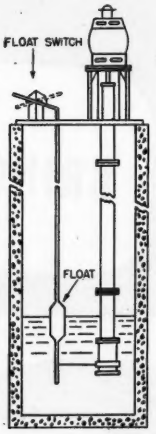


Fig. 1. Float control to protect pump against low water in well, suggested by E. R. Webber

purpose, as in Fig. 2. The regulator should be installed in the 6-in. line below the tank. Raising the water level in the tank would increase the pressure under the diaphragm, causing it to rise and actuate the lever arm operating the control switch. Adjustments would have to be made to control the proper starting and stopping water levels in the tank.

To simplify the set-up, I think both pumps should be used. This would cut the pumping time in half. As an illustration, the pumps having been out of operation for several hours, the water level in the tank reaches the low point and the pumps are started by the pressure control apparatus. If the water level in either or both wells became low, the float would shut down the pump or pumps until the water returned to normal level when the pumping service would be automatically resumed. Disconnect switch should be provided in the line to each pump motor to permit making repairs or to segregate the unit if it were decided to use only one pump.

It is hard to advise F. J. H. how to keep the sand out of his wells. If the accumulation requires months to reach the point where it interferes

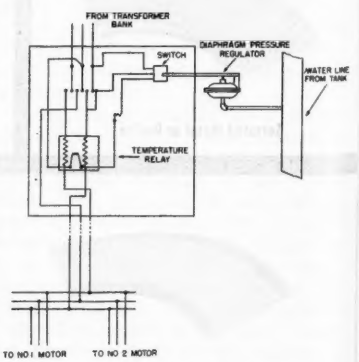


Fig. 2. How E. R. Webber would connect a diaphragm pressure regulator to control the two pumps

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with pumping operations, I would advise the use of a portable sand pump with suction hose long enough to be moved to any point on the well floor. This would take care of the situation at a very low first cost. Of course, if the sand enters the wells at a rate making it necessary to remove the residue every few weeks, it might be advisable to install permanent pumps in each well. Any pump manufacturer will be glad to furnish data on this equipment at any time.

It is next to impossible to make any concrete tank leak proof. A coat of good concrete paint might eliminate the trouble for a period of time, but it would probably have to be repeated at regular intervals. Care must be used in selecting a paint that will not effect the taste of the water.

West Duluth, Minn.

E. R. WEBBER.

Details of Pressure Control from Erisman

BY MEANS of the variation in hydrostatic head or pressure, F. J. H. can use the pumps to start automatically at a predetermined low tank level and to stop at the high level setting.

FJH states that the pumps are capable of delivering 60 gpm and that only one pump is used at a time and only for a period of 4 hr in 24. Therefore the approximate amount of water used daily would be equal to $4 \times 60 \times 60$ or 14,400 gal.

Since the tank diameter is 27 ft, then the amount of water per foot of tank level would be approximately equal to $27^2 \times 0.7854 \times 1 \times 7.5$ or 4295 gal. Then the daily variation in tank level would be approximately as $14{,}400 \div 4295$ or 3.3 ft.

Disregarding slight differences due to temperature, the resulting pressure drop would equal, approximately 0.4332×3.3 or 1.4 lb.

A mercoid type of pressure operated switch can be purchased that can be set for differentials as low as 2 or 3 oz. In this case it could be set for a 1½-lb differential corresponding to the difference in head between the minimum and maximum tank levels.

Since only 4 hr pumping at a rate of 60 gpm is required to make up water used in 24 hr, it stands to reason that the peak demand at any time during the 24 hr is much less than this. And even if the peak was equal to the capacity of one pump, the 6-in. main is large enough so that there should not be enough pressure fluctuations to cause erratic operation of the pumps, under an automatic control as mentioned above.

A small surge chamber can be connected ahead of the mercoid to smooth out any small pressure pulses that might occur.

I believe that both pumps should be operated simultaneously from one mercoid to divide the service and wear between the two pumps.

A two-pole, single-throw type of mercoid will handle both push-button

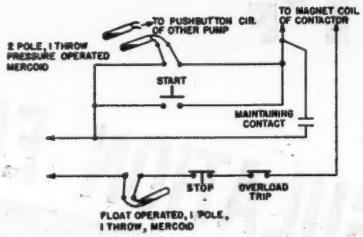

Diagram by Jesse L. Erisman showing how to connect float switches in the circuit

circuits on the pumps and will allow independent manual starting and stopping of both pumps when hooked up as shown.

Float-operated switches can be used in each well to prevent either pump or both from operating when the water level is too low. A chain type of float switch would probably be the easiest to install. These switches would be connected in the pushbutton circuit as shown in the diagram.

In the 24-ft deep storage tank, the water level probably never exceeds 22 ft. This would require an approximate pumping head of 75 psi. Since the volume of water delivered by centrifugal pumps, in general, is greater as the head pressure is lowered, this might explain the 60 gpm delivery of the pumps, instead of the 50 gpm design rating at 80 psi. In similar cases, motors driving centrifugals have been overloaded.

A large pressure gage, reading from zero to 100 lb or preferably from 50 lb to 100 lb, could be installed on the line near the pump house and calibrated to read in feet of height in the tank, making further use of the field glasses, for long distance observation, unnecessary.

Operating automatically, the pumps will probably require a cushioned type of check valve to prevent heavy slamming when the pumps go down.

To prevent the concrete storage tank from leaking, it could be painted with a waterproof cement paint, which is now on the market. This paint is supposed to be "okay" even when applied to wet surfaces.

As to the sand problem, I will leave that for someone to answer who is more familiar with "well operation."

JESSE L. ERISMAN

St. Louis, Missouri

Answer No. 308

Are Gaskets and Packing Supplies or Maintenance?

IN WORKING UP power plant cost analyses, said Z. K. in the September issue, there seem to be two schools of thought on supplies and maintenance. To which of these categories should you assign such things as gaskets, packings, lubricants, lamps, etc.?

They Are Supplies, Says Parks

GASKETS AND packing are supplies, not maintenance. Maintenance means the act of maintaining and you can't maintain anything with part of it in the store room.

When a man is ordered to overhaul a piece of equipment, he first examines the machine to find what he needs. He then goes to the stock room and orders out the required material and then goes to work. If packing were maintenance, then why not lamps? A socket is no good without a bulb. Or whatever is stored in the supply room that does not go to maintain some part of the plant at one place or another?

Material cannot be charged to maintenance until it is used, because what would you charge it to? Each and every piece of equipment is listed on the books as to: cost; maintenance; and depreciation. So you can't charge gaskets to a boiler until they are actually put on. You can't charge rings of packing to an air compressor until it is put in; then, and only then, is it maintenance.

Baltimore 13, Md.

CHAS. W. PARKS.

Changing Insulators with Rope Blocks

Several employees were changing out insulators on an energized 66 KV line. The structure was a standard type "A" two-arm suspension structure supporting a three phase line. One string of insulators had been changed out on the bottom crossarm by using rope blocks attached to the top crossarm and during this procedure a light rain started to fall. The men completed the work of changing out the insulators and waited some ten or fifteen minutes for the weather to clear before starting work on the top string of insulators on the opposite side of the pole. The rope blocks were fastened to the crossarm and conductor with about two feet of rope between the crossarm and the conductor. The crossarm bond wire had been removed from the pole ground with 6 or 8 inches of clearance. A static arc developed in the rope blocks after the conductor was separated from the suspension insulators and the employees immediately reconnected the conductor and insulators. However, the rope blocks flashed over before they could be disconnected from the conductor. This resulted in one of the employees having both eyes severely burned and blistered from the electrical arc.

The accident report states that it was caused through the use of improper tools and devices and further states that rules were not observed although instructions were followed. This last more or less conflicting statement is, no doubt, made because information was given that protective devices were not provided for this job. In order to prevent a recurrence of an accident of this kind, it is stated that no more work of this nature until further instruction is given and proper tools provided.

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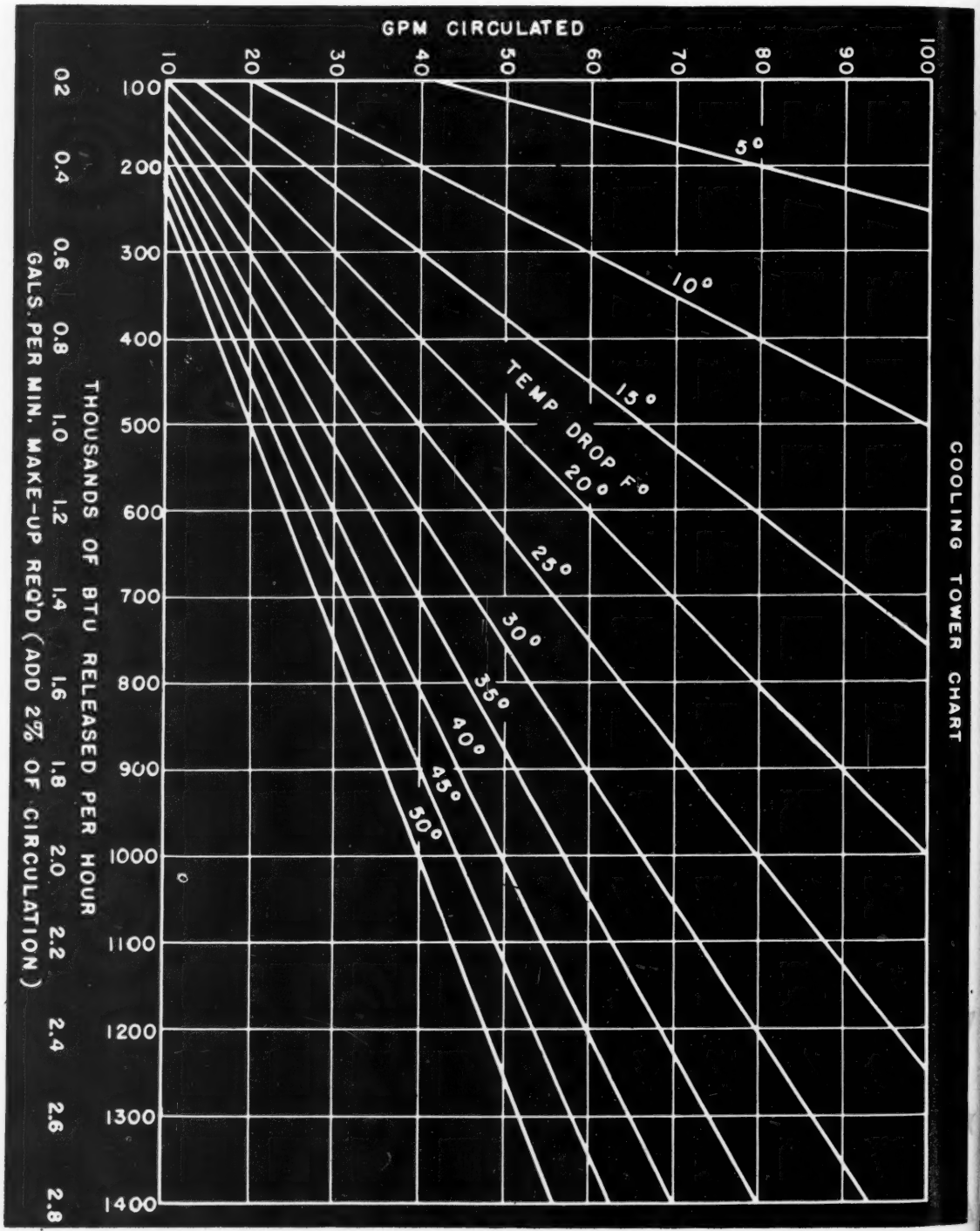
COOLING TOWER CHART

By Bill Maddock

By using multiples of ten this chart may be made to cover nearly any heat release range required and gives the make-up required on account of evaporation



SUN COMPRESSOR LUBRICANT

Ends Quarterly Shutdowns for Carbon-Cleaning in Air-Compressor

Compressor carbon was an unwanted by-product of a big plastics plant. The steam-driven Ingersoll-Rand air-compressor, with mechanical force-feed lubrication, was using a good brand of oil, but produced a "usual amount" of carbon.

Every three months, a shutdown of the air-system was made necessary while compressor-heads were taken off and parts scraped clean.

Carbon disappeared, however, after the management switched to a Sun lubricant. For ten months, with the Sun oil, it was not necessary to clean-out carbon once. Three complete shutdowns were thereby avoided.

Sun compressor lubricants, specially refined to withstand the temperatures and pressures of compression-cylinders, are typical of Sun industrial products. In light and heavy industry . . . in factories, textile mills, mines, tanneries, chemical plants . . . Sun lubricants, fuels, processing oils, and technical products are known for their quality and for the know-how of the men who make them. Call the Sun man near you for information on new products for your industry, or write

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Liquid Fuel Purification

Chemical and physical qualities of petroleum fuels vary widely—Exacting industrial uses of liquid fuels call for specifications with narrow tolerances —Causes of contamination between refinery and point of use—Cleaning Diesel oil, gasoline and furnace oil just before use is recommended practice

By **BEN F. HUNTER** *Consulting Engineer, Honan-Crane Corp.*

LIQUID PETROLEUM fuels can vary widely with reference to chemical properties, gravity, boiling range, viscosity, and pour point. However, they fall within three general classifications, each of which may be divided into further classifications, namely:

A. Refined Fuels:
- Gasoline
- Kerosene
- Diesel Fuels
- Furnace Oil (heating fuels)
- Industrial Furnace Oils

B. Crude Petroleum:
- Diesel Fuels
- Navy Furnace Oils
- Industrial Furnace Oils
  - Bunker fuel A
  - Bunker fuel B
  - Bunker fuel C

The suitability of a fuel oil for a specific requirement varies with:
(a) Chemical composition (ignition and burning characteristics)
(b) Gravity (pounds or Btu's per gallon)
(c) Boiling range (ignition and burning characteristics)
(d) Viscosity (fluidity, lubricating and atomization characteristics)
(e) Pour point (pumpability at low temperature)

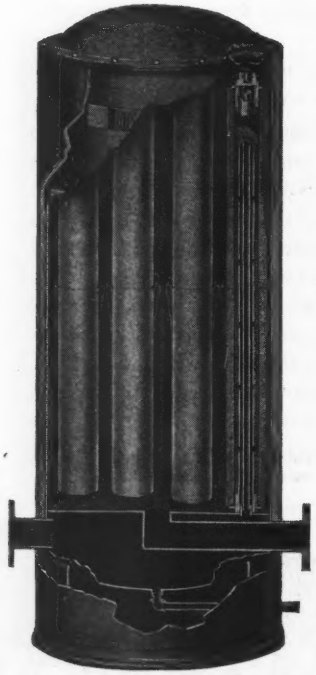

Fig. 1. Cross Section of fuel oil purifier

Purchasing specifications for liquid fuels, depending on the purpose for which they are intended, may include:
- Initial boiling point
- Boiling Range
- End Point
- Color
- Octane Rating
- Cetane Rating
- Flash Point
- Gravity
- Viscosity
- Sulphur
- Non-gumming or non-corrosive properties
- Neutralization Number
- Insolubles
- Water
- Sediment
- B.S. or Bottoms

Each of these properties is of prime importance in accordance with the purpose for which the fuel is intended. All properties can be controlled, within reasonable limits, at the refinery. However, all liquid fuels are subjected to contamination from liquids, solids, etc., during transportation, storage, and handling. Water and abrasives are, perhaps, the most serious contaminating influences encountered during transportation, storage, and handling.

In most instances, water contamination can be removed by gravity settling. Finely divided abrasives in the form of dust, dirty, or iron oxides present a more difficult problem; and most liquid fuels, regardless of the precautions taken during transportation and handling, contain varying amounts of abrasive materials in suspension.

Liquid fuels pass through a series of storage tanks and transportation media after they are manufactured and before they reach their final point of consumption, such as:
(a) Bulk storage tank at the refinery.
(b) Pipe lines, tankers, or tank cars.
(c) Terminals.
(d) Tank cars.
(e) Bulk station tank storage.
(f) Tank trucks.
(g) Drums or consumer storage.
(i) Supply tanks for the individual engine.

In general, fuel storage tanks, pipe lines, etc., are constructed of steel (ferrous metal). Corrosion of the surfaces of the metal of fuel oil storage equipment exists generally, varying with design, condition of the equipment, location, average per cent humidity, variable ambient temperatures (influencing breathing), quality of the fuel (corrosive tendencies), and volume of fuel handled through a given storage. Varying amounts of finely divided iron oxides (abrasives) are suspended in the fuel and eventually reach the engine, increasing wear on the fuel injection system, spray nozzles, and/or engine parts.

In addition to iron oxides (abrasives), resulting from corrosion of the metal surfaces of storage and transportation equipment, fuel oils are subjected to contamination by varying percentages of dust, dirt, and other forms of abrasives.

In spite of the extreme precautions taken by refiners and distributors to prevent contamination and remove abrasives from the fuel, a sufficient amount is usually contained in the fuel to increase wear in fuel injection systems and engine parts. A purifier on each unit to remove solids from the fuel, prior to entering the injection system or engine, is the most effective and satisfactory method known. To be effective, the purifier must remove all solids, regardless of their micron size.

Diesel Engine

The majority of Diesel engines manufactured employ a mechanical or solid injection fuel system. The solid injection fuel system is, perhaps, the most exacting, precision-built piece of mechanical equipment commonly encountered in any machine. Fuel injection systems are built from selected metals, fitted and lapped to extremely close tolerances.

A solid or mechanical fuel injection system is operated at high speeds and high pressures and must be so constructed as accurately to deliver a measured quantity of fuel at a given pressure, within a given time, in a properly atomized condition to the combustion zone to insure proper combustion and the maximum efficiency of the engine. The slightest amount of wear or obstruction will impair timing, injection pressures, and proper atomization, any or all of which, when not in their original, perfect condition, will affect complete combustion of the fuel, resulting in:
(a) Poor fuel economy.
(b) Dilution of the crankcase lubricating oil.
(c) Formation of deposits, sludges, lacquers, etc.

The formation of deposits in the internal combustion engine is, perhaps,

LONG life, low overhead, satisfaction reaching far into the future—these are the considerations once again governing the planning of piping systems for peacetime permanence. In oil refineries and food-processing plants, among equipment manufacturers and utility engineers, Tube-Turn welding fittings meet these demands.

Such an installation as this would be impossible with screwed or flanged fittings, but the compactness and simplicity of Tube-Turn elbows fit the situation easily. Their strength, weight-saving, and ease of insulation offer added reasons for specifying Tube-Turn welding fittings.

More than 4,000 items make up the complete Tube Turns line. They are available now. For complete information on the superiority of Tube Turns' exclusive manufacturing methods and data on successful installations in many industries, write for Tube Turns Catalog 111.

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Selected Tube Turns distributors in every principal city are ready to serve you from their complete stocks.

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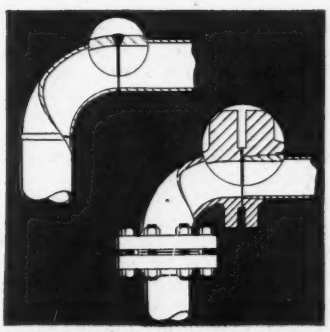


See how Tube-Turn elbows save space! No leaks, gasket changes or bolt-tightening to worry about—maintenance and replacement troubles are avoided.

TUBE-TURN TRADE MARK *Welding Fittings and Flanges*

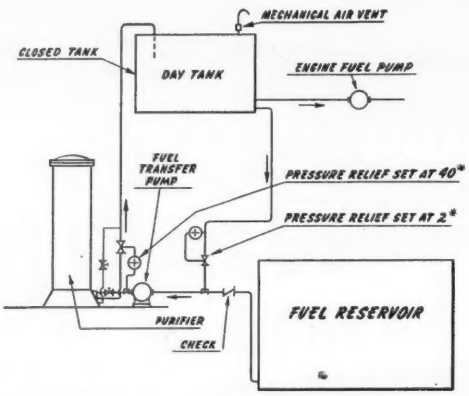


Fig. 2. Piping diagram for fuel oil system using purifier without additional pump

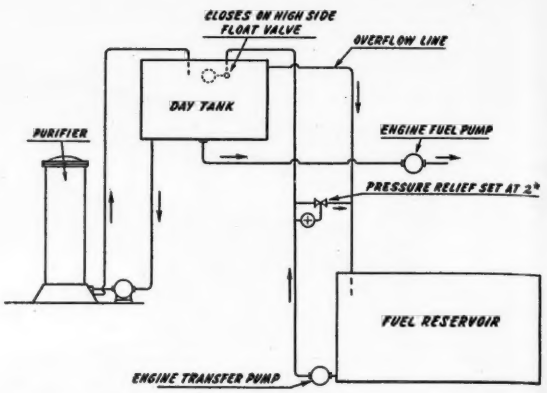


Fig. 3. Piping diagram for fuel oil system using purifier with pump

the most serious operating difficulty, and, in far too many instances, is blamed on the lubricating oil, when it is directly traceable to:

(a) Worn or obstructed injection system (resulting from abrasives in the fuel).
(b) Improper timing, frequently a result of excess wear in the timing mechanism (resulting from abrasives in the fuel).
(c) Worn or clogged spray nozzles (resulting from abrasives in the fuel).
(d) Too low compression, resulting from worn cylinders, piston rings, etc., (resulting from abrasives in the fuel or intake air).
(e) Excess deposits, resulting from incomplete combustion of the fuel, traced to any or all of the above mentioned conditions.
(f) Excess bearing wear, resulting from abrasives from the intake air or fuel finding their way into the lubricating oil.

Operators, in general, have long appreciated the importance and economy of adequate and effective air filters for the intake air. The more progressive manufacturers and operators equip their engines with air filters and carefully observe their operation. This practice is highly important. Adequate and effective air filters should be a part of every internal combustion engine if the maximum engine life and operating efficiency are to be expected.

The heart of the Diesel engine is the fuel injection system. Whereas, abrasives, taken into the engine with the intake air, accelerate wear on the cylinders, pistons, piston rings, valves, bearings, etc., abrasives in the fuel accelerate wear on the injection system, as well as these other moving parts of the engine.

The more advanced and progressive operators now appreciate the importance of clean fuel in maintaining the efficiency of the fuel injection system to insure proper combustion and minimize the formation of objectionable deposits. Abrasives taken into the engine with unpurified fuel may be proportionately less than abrasives in the intake air of an engine operated without an air filter. However, excess wear on the injection system and its effects on improper combustion may be more damaging to the over-all efficient operation of the engine.

Gasoline or Carburetor Type Engine

Abrasives in gasoline or carburetor type engine fuels create excess wear on the moving parts of the engine, eventually impairing its efficient operation.

Adequate gasoline purification equipment and air filters are equally as essential to the gasoline engine as to the Diesel engine. Especially is this true with trucks, farm tractors, and contractors' equipment where the air carries excessive amounts of abrasives. Appreciable quantities of abrasives can enter the fuel, especially in the final fueling operation of farm tractors, contractors' equipment, trucks, etc., emphasizing the importance of a fuel oil purifier on each engine to prevent such abrasives from entering the engine and taking their toll, creating excess wear on all moving parts.

Furnace Fuels

Fuel oils for household and industrial heating furnaces are refined fuels (usually marketed as "furnace oils" or "refined fuels"). In all such equipment, the fuel oil is delivered, under pressure, through spray nozzles to the combustion zone.

Fuel oil pumps, spray nozzles, etc., of such equipment must be precision-built, and so maintained, if the maximum of operating efficiency is to be had. Excess wear on pumps, wear or obstruction of spray nozzles, resulting from abrasives in the fuel, is, undoubtedly, responsible for eventual inefficient operation of most furnace equipment. Adequately fuel oil purification equipment should be a part of every household or industrial furnace.

The primary function of the filter or purifier for liquid fuels is the removal of abrasives of all types and sizes. While the conventional strainer or strainer type filters are helpful in removing abrasives of larger micron size, they will not remove the finer abrasives which also cause excess wear of the moving parts of the injection system. The importance and economy resulting from the complete removal of all abrasives from refined fuels and gasoline cannot be questioned, and should prove a simple and inexpensive procedure.

Selection of the filter or purifier, however, is all-important and should be based on its ability completely to remove all abrasives and solids, regardless of their nature or micron size. Fuller's earth is an effective and economical filtering medium for this purpose.

Clean fuel, free from abrasives, will eliminate unnecessary wear on the injection system of internal combustion engines, insure more complete combustion and minimize the formation of objectionable deposits and subsequent operating difficulties usually blamed on the lubricating oil.

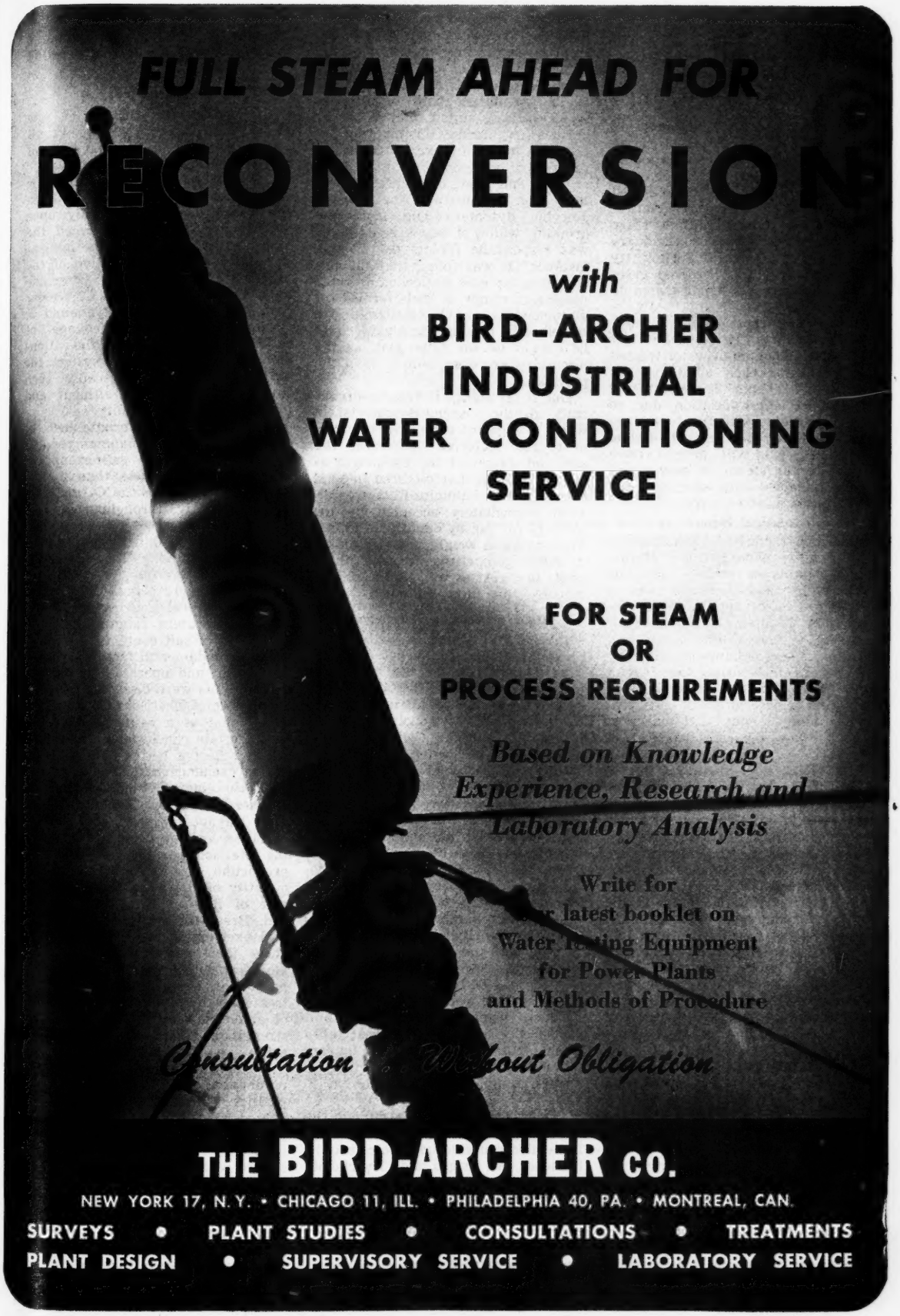
Too much emphasis cannot be placed on the importance and effects of clean fuel in the economical operation of the internal combustion engine.

Simplified Practice Regulating Valves

THE DIVISION of Simplified Practice, National Bureau of Standards, has submitted a proposed simplified practice recommendation for automatic regulating valves to producers, distributors, and users of these valves for approval or comment.

Such valves are used in industry for controlling the temperature, pressure, level or rate of flow of fluids. The purpose of the recommendation is to establish as a useful standard of practice a simplified list of pressure ratings and sizes of seven types of these valves, made of steel, iron, and bronze.

The recommendation was developed in co-operation with a simplified practice committee of manufacturers and if approved will retain on a voluntary basis the simplified practice features of a mandatory order which was effective during the war.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Sixth Water Conference

(Continued from page 86)

tant position in this field in recent years.

Essentially this process is based on the fact that if a liquid is distributed in a thin film and a vacuum applied, the dissolved gases such as oxygen and carbon dioxide will be removed readily until only a small residual remains in solution. Multiple stage deaerator construction or secondary chemical treatment will further reduce the amount of dissolved gases if this need can be demonstrated to be economical.

The purchase cost of single stage installations can be estimated at $10,000 for 1000 gpm of water treated plus $3000 for each additional increment of 1000 gpm. These costs will show appreciable variation due to local conditions, structural requirements and completeness of design. Operating costs will depend upon availability of steam or power and the completeness with which the dissolved gases must be removed.

Industrial Waters

Water characteristics and requirements for the manufacture of Rayon, with the limits on residual chemicals in the water, and chemicals used in the treatment of supply, were discussed by William S. Habbart of American Viscose Corp. Details and location of seven plants operated by the American Viscose Corp, with water characteristics at each were given and a description of a typical water plant layout and chemical treating flow diagrams were presented.

Well waters are growing in importance yearly due to the demand of industry for constant low temperature water in large volume, for water cleaner than most silt laden streams, and municipal requirements for pure water to augment surface supplies, stated John R. Charles, Layne-New York Co., Inc. The invention of the vertical turbine type of well pump, the gravel wall well, the introduction of the use of silicon bronze well screens, the improvement and application of oil field drilling equipment to water well drilling, the sealing of outer casings with neat cement grout under pressure, the use of electric welded casings, have increased the production and reduced the maintenance cost of the modern water well.

The vast majority of all ground water supplies are obtained from the sands and gravels which occur above bed rock. In the Pittsburgh district these sands are of glacial origin occurring along the major stream valleys, more consistent as glacial and outwash in northwestern Pennsylvania and New York State, and in Ohio. Elsewhere the unconsolidated deposits are continental in origin, may extend to considerable depth, all laid down by water, and all more or less stratified. His discussion was confined to the development of supplies from these unconsolidated deposits.

In a discussion of diatomaceous earth filtration, H. E. Hollberg, and H. N. Armbrust, both of Proportioneers, Inc., stated that a water purification unit using this type of filtration medium makes possible the removal of suspended solids of both organic and inorganic nature. The need for eliminating the elusive amoebic dysentery bug from the drinking water of our armed forces was responsible for its use in this instance. It was found that the microscopic particles suspended in water passing through a mat formed of diatomaceous earth (microscopic skeletons of pre-historic algae) could be caught on the filter mat, as the interstices are even thinner than the particles.

Due to its ability to remove practically all the suspended material in water at high filteration rates, which, of course, materially decreased the size and weight of the equipment as compared with that required in sand filtration, the diatomite filter was almost immediately accepted by the military for use by our armed forces. This saving in weight and size makes it highly competitive to sand filters as its first cost as well as the cost of housing the filter is much lower.

Water Softening by Electrolysis

Electrolytic water softening employs the cathodic influence of a two compartment cell for the major effects of hardness and dissolved solids reduction, said R. E. Briggs, Industrial Chemist, Metropolitan Water District of Southern California. The highly alkaline water leaving the cathode compartment is clarified before subjecting it to a portion of the enodic influence for pH reduction. Electro-chemical effects dominate both influences; ion migration in a minor role may be emphasized or discouraged within certain limits to suit the demand for water quality. The process may be applied to both cold and hot waters, the latter being the more economical. Electric power, varying with the amount of softening and dissolved solids reduction accomplished, may be controlled to between 2 and 6 kwh per 1000 gal of final product. Operation at 4 volts approaches maximum electrical efficiency but is accompanied by an initial cost more than double that of a unit designed for operation at 8 volts.

Waters considered too difficult to handle by conventional methods may be rendered usable under electrolytic influence, Mr. Briggs said. The chemical analysis of the raw water may be used to calculate the power required for a sought product; accomplishments, although limited in scope, are still considered highly versatile. Specific attention may be given to precipitation of certain cation constituents and the system thus made somewhat selective. Electrolytic water softening is adaptable to automatic controls to maintain a given operating condition.

Ionic Exchange Practice

Although in the passage of raw natural waters through an acid activated cation exchanger, the bulk of the salts in the water is converted to the corresponding acids, there is always a certain amount of salt leakage which depends primarily upon the strength of the acids formed, the concentration of salts in the influent and the degree of exhaustion of the exchanger, was a statement made by W. E. Manring and M. C. Welder both of the American Cyanamid & Chemical Corp. This leakage of cations limits the utility of the cation-anion two bed exchange system for demineralizing water because such cations appear in the effluent and obviously affect its quality.

The use of four alternate beds of cation and anion exchangers reduces the extent to which cations appear in the effluent to less than 2 ppm sodium calculated as $CaCO_3$, and does so consistently throughout a run. Chemical removal of CO_2 is accomplished on the fourth bed, and a neutral unbuffered effluent produced by proper activation of that bed. These results are being accomplished with economical regenerant dosage and with waters ranging up to a high level of salt content.

Some fundamental factors affecting the design and operation of ion exchange units were discussed by R. B. Thompson, of The Dorr Co, Inc., who stated that as a result of extensive tests, certain conclusions are reached which reflect a better understanding of ion exchange materials and their use. He claimed that all the acid regenerated cation exchangers exhibit leakage of ions. The quantity of cation leakage depends largely on the total solids in the raw water, the proportion of alkalinity present, the quantity of regenerant used and the rate of flow of water through the bed. Break-through capacities of several exchangers are given and they show that most cation exchangers have capacities that depend on the proportion of alkalinity in the untreated water and that the capacity of anion exchangers depends on the strength and kind of the exhausting acid.

Water containing calcium as the predominating cation will show capacities appreciably less than those quoted if sulfuric acid is used to regenerate. This is because of the formation of a precipitate of calcium sulfate within the bed. To avoid this loss in capacity the use of a strong brine is advocated ahead of the sulfuric acid on each regeneration.

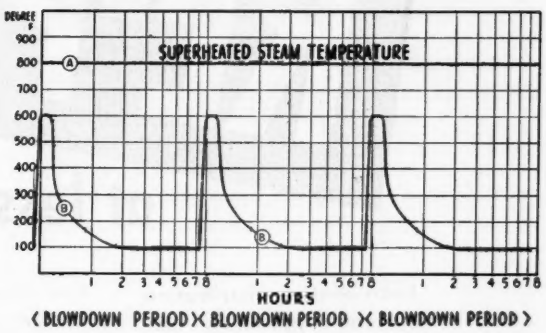
All papers presented at the conference together with the discussions will be printed in full in the Proceedings of the Sixth Water Conference which will soon be made available.

HOW EDWARD *Solved* THE SPECIAL PROBLEMS OF BLOW-OFF VALVE SERVICE

PROBLEM:

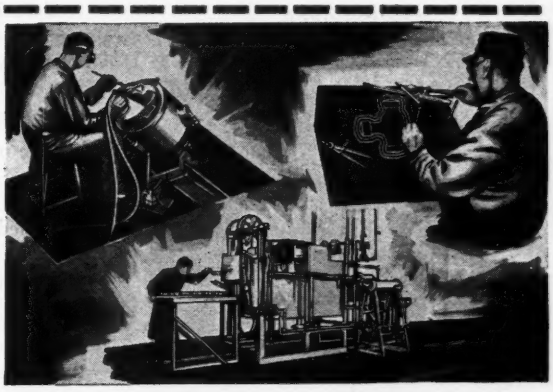
Two ever-present operating conditions put unusual strain on blow-off valves. They are, (1) abrasive action of grit, scale and sediment blown through the valve, (2) expanding and contracting of valve parts caused by wide and repeated variations in temperature.

The chart shows temperature variation in a typical blow-off valve installation. Line A indicates temperature constancy of valves operating in steam lines. Line B shows temperature fluctuations in blow-off valve operation from boiler room to saturated steam temperature in a matter of *seconds,* followed by *long periods* of cooling until the next blow-down period.



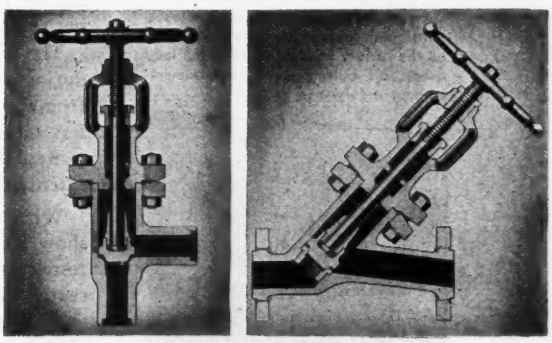
SOLUTION:

Edward attacked the two-fold problem in two ways. First, new techniques were developed for hardfacing seats, disks and other parts which get the greatest wear, and new heat treating equipment was designed for non-scaling heat treatment of parts *after finish machining.* Second, dies and patterns were designed to equalize metal sections so that distortion in heating and cooling was controlled and a valve closed tight under high boiler temperature would still be tight after cooling.



RESULT:

Designed specifically for boiler blowdown conditions, today's Edward blow-off valves fit any installation requirement, need almost no maintenance attention. Globe stop type principle is retained for tight seating, less packing wear, and easier repacking. Bulky or irregular metal sections that cause distortion of working parts in frequent heating and cooling are eliminated. Internal parts are few, hence there is less clogging, erosion, adjustment or replacement. These and other design advantages are outlined in detail in the new Edward Blow-Off Valve Catalog, No. 12-D. Write for your copy.



Edward blow-off valves come in straightway or angle designs, flanged or socket welding ends, for service from 150 to 1500 lb sp.

EDWARD *Steel* VALVES

THE EDWARD VALVE & MFG. CO., INC.
EAST CHICAGO, INDIANA

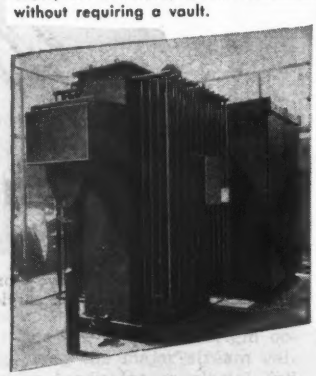
Look to Edward for the Best in New Steel Valve Developments

RE-POWERED

at less cost than *patchwork!*

Load-center distribution system supplanting old-time system step-by-step will pay the full costs of replacement

Unit substations are easy to install; the use of Pyranol* or dry-type transformer sections, with safety metal-enclosed switchgear, permits them to be located on the factory floor adjacent to the load areas, on balconies, or in basements without requiring a vault.



Where building layout makes it desirable, unit substations are built for installation outdoors.

*Pyranol is the G-E trade mark (Reg. U. S. Pat. Off.) for askarel, a noninflammable, nonsludging insulating liquid.

Like many older plants of moderate size, this one was saddled with an obsolete power distribution system. A recent rise in power requirements, necessitating extensive additions to the old system, brought the problem of replacement to a head.

A study by G-E engineers showed the wastefulness of extending the outdated 2-phase system with 5-wire feeders such as originally used. Instead, they suggested a *step-by-step plan* for converting to load-center power distribution. This conversion plan is paying its own way right from the start.

1. The immediate need for extra power is being met with a new G-E load-center unit substation. The customer saved 5 per cent on first cost alone by buying standard three-phase equipment for the expanded main service. The total cost of *all* the three-phase high-voltage feeders was less than the cost of just the low-voltage two-phase extension, had the need been met by patchwork.

2. Later, additional load-center unit substations will be installed, until the old system is entirely supplanted. Savings resulting from the 2½ to 5 per cent extra efficiency of the three-phase system will amount to $2000 to $4000 per year in power costs alone. This will pay off the costs of complete modernization at some 20 per cent per year.

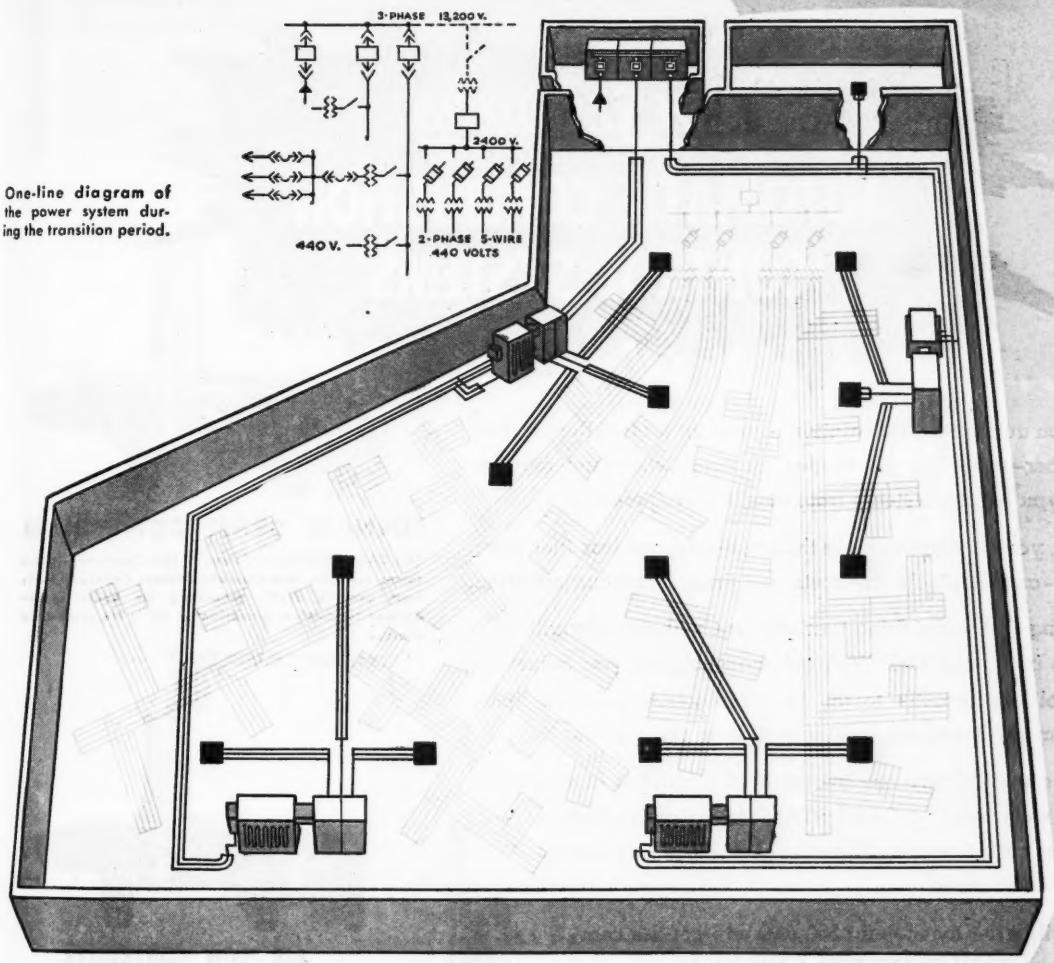
The changeover is being made without production shutdowns during installation of the three-phase system, or in the changeover from the obsolete system. The new system will be safer, and require less servicing time. When completed, the customer will have a power distribution system *engineered for growth,* whatever the extent of the plant's future power needs.

What does a check-up of your own power distribution system show as to voltage conditions, outages, maintenance costs, and restrictions on plant expansion? Perhaps modernization the load-center way can be planned so as to be fully self-liquidating. Ask your local G-E representative, or write for Bulletin GEA-3758. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

KEEP ON BUYING **BONDS** — AND KEEP ALL YOU BUY

FOR GROWTH

One-line diagram of the power system during the transition period.



New feeders (black) will replace the old feeders (yellow) and establish a simplified, modern distribution system.

LOAD-CENTER POWER DISTRIBUTION SYSTEMS

GENERAL ELECTRIC

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THIS CONSTANT AUTOMATIC ATTENTION

The Answer

TO INCREASED BOILER CAPACITY...

CASH STANDARD

AUTOMATIC COMBUSTION CONTROL SYSTEMS

WHEN you automatically maintain a constant draft in the combustion chamber—meter the air needed for combustion and regulate fuel feed, you get more steam from existing equipment.

But, also, you accomplish more than that—you use less fuel—coal, oil, or gas—and eliminate the costs and error of human attention.

Over-firing and under-firing that happens without automatic control results in wasted fuel. With automatic control you adjust the rate of fuel feed exactly to the load requirements at all times. Thus, steam pressures are held within very close limits.

The three units shown are available in a number of variations. Therefore, selection of a CASH STANDARD Control System to meet any condition and dependably work on any system is easily accomplished.

If you will write for Bulletin 300 you will get the complete story of CASH STANDARD Automatic Combustion Control and see exactly how it works daily to your benefit.

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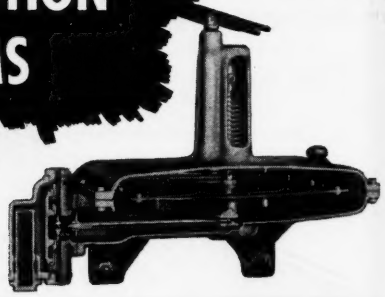
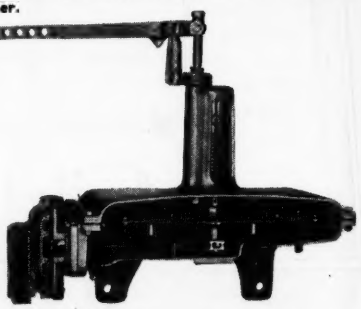


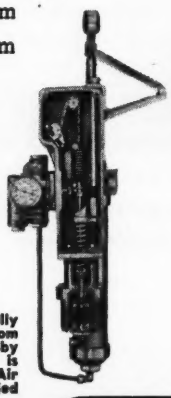
FURNACE DRAFT CONTROLLER

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber.



AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion—hence, money saving.

A. W. CASH COMPANY

DECATUR, ILLINOIS

CASH STANDARD CONTROLS . . VALVES

STRENGTH

FOR SAFETY AND LONG-TIME SERVICE

Specify Vogt DROP FORGED STEEL FITTINGS

SCREW END TYPE

For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

SOCKET WELD TYPE

For schedules 40, 80 and 160 pipe — Sizes 1/8" to 6"

Round-the-clock operation of oil refineries, chemical plants, steam plants, etc., essential to the continuous flow of war products to the United Nations, is all in the day's work for these fittings. Today, as in peacetime, Vogt drop forged steel fittings make a major contribution to the efficient functioning of pipe lines in plants vital to the war effort.

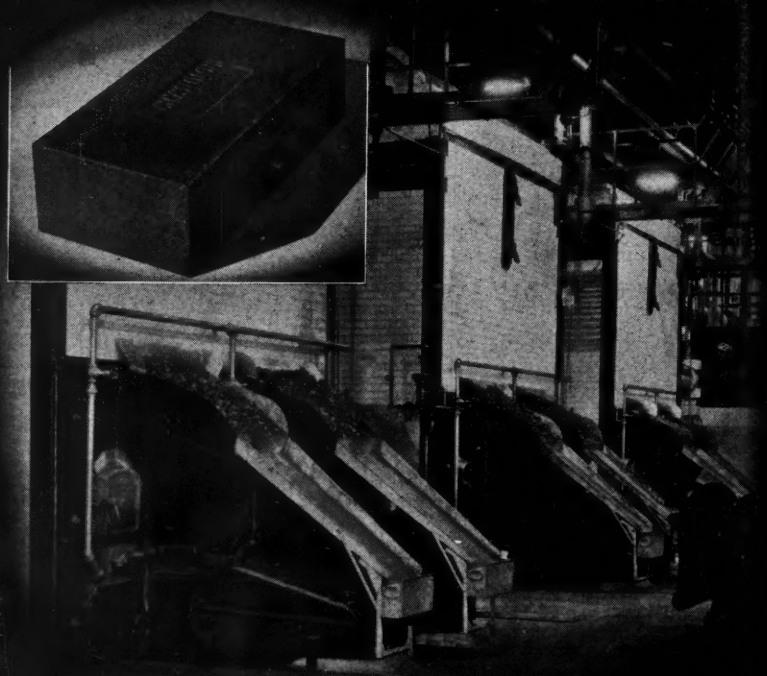
Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled materials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy.

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-8 will aid you in their selection and proper application.

HENRY VOGT MACHINE CO., Inc., LOUISVILLE 10, KY.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

CRYSTOLON BRICK - Give to Boiler Furnaces a Refractory Lining that Stands the Gaff... Cuts Fuel and Maintenance Costs



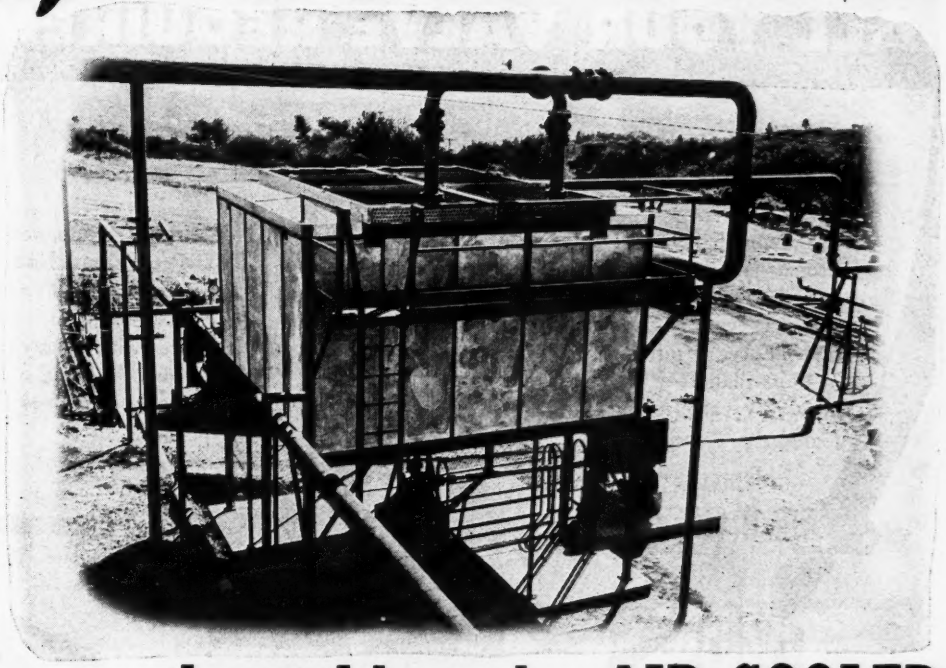
Uninterrupted operation with avoidance of costly "downtime" for lining repairs is a twofold reason why power plant men prefer CRYSTOLON Brick for boiler furnace linings. Furthermore, these densely constructed silicon carbide bricks stand up, even at the highest temperatures, and they are resistant to abrasion and to the penetration and erosive action of slag. The few clinkers which may adhere to CRYSTOLON Brick are easily "barred" loose without damage to the surface of the brick.

NORTON COMPANY

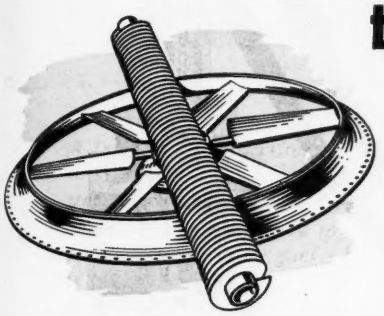
Worcester 6, Massachusetts

Norton Longer Lasting Refractories

Investigate FIN-FAN



the multi-service AIR-COOLED heat exchanger



This symbol denotes the principle of the FIN-FAN Air Cooled Heat Exchanger which combines the long Griscom-Russell experience in the field of heat transfer equipment and the extensive Fluor experience in air-moving systems, mechanical equipment and structures.

The important advantages of the FIN-FAN Exchanger warrants its investigation for practically every condensing and cooling service. Note these features:

PROVEN WIDE ADAPTABILITY highly successful operation under wide variety of duties—suitable for liquids, gases, and vapors at pressures up to 5,000 psi and temperatures up to 1500°F.

ECONOMICAL OPERATION independent of wind velocity or direction . . . forced draft air circulation with highly efficient fans having power saving variable pitch blades, and uniform air distribution over K-Fin cooling sections.

EASE OF INSTALLATION, OPERATION AND MAINTENANCE a complete, "package type" unit that can be installed on the ground or on top of buildings . . . no water supply equipment or piping . . . all mechanical equipment sturdy and readily accessible, with flexible operating control.
Write for complete information.

Some FIN-FAN Applications
- Exhaust steam condensing
- Engine jacket water cooling
- Gas cooling
- Still overhead and reflux condensing and cooling
- Oil cooling
- Compressed air cooling
- Solution cooling
- Refrigeration system condensing

or a combination of one or more services with the same unit

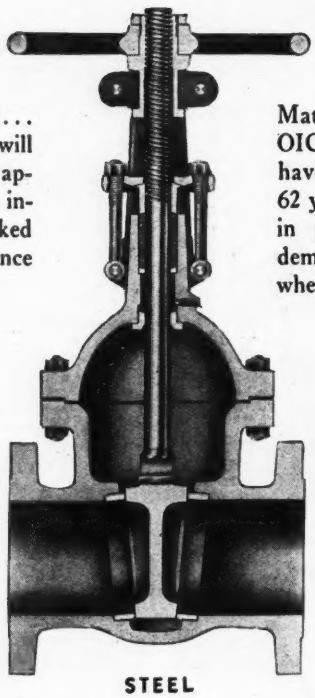
THE GRISCOM-RUSSELL CO.
285 Madison Ave., New York 17, N. Y.

GRISCOM-RUSSELL
Pioneers in Heat Transfer Apparatus

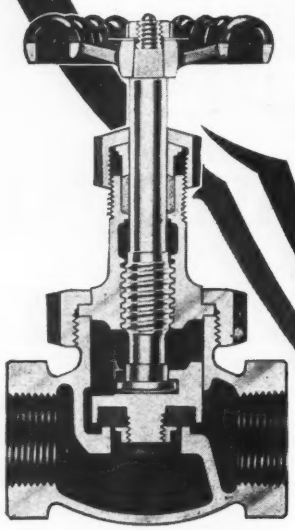
ONE DEPENDABLE SOURCE for ALL YOUR VALVE REQUIREMENTS

In the complete line of OIC Steel . . . Bronze and Iron Valves, you will find the right valve for every application, with correct trim to insure the best performance . . . backed by more than 62 years of experience in quality valve manufacture.

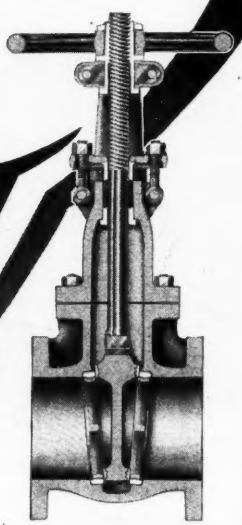
Matching the superior qualities of OIC Bronze and Iron Valves that have been outstanding for more than 62 years, OIC Cast Steel Valves are in pace with today's emergency demands . . . filling a definite need wherever steel valves are required.



STEEL



BRONZE



IRON

OIC time-tested Bronze Valves long have been outstanding in the field . . . providing longer uninterrupted service . . . lower maintenance and replacement costs . . . greater corrosion resistance. In OIC's you get all the benefits it is possible for valves to render.

OIC

Since 1883

In OIC Iron Valves you get extra-rugged construction . . . greater overall weight . . . simplicity of construction . . . greater ease and maximum efficiency of operation . . . guides cast integrally, insuring positive wedge alignment .

WRITE TODAY for copy of the new OIC Steel Valve Catalog. There is no obligation.

THE OHIO INJECTOR COMPANY

WADSWORTH, OHIO

Quality Leaders in Valve Manufacture Since 1883

There is far more here than meets the eye

★ *In a casual inspection, the many Taylor Forge Nozzles like this seen in big power and process plants simply appear to be sturdy, workmanlike outlets for boilers and pressure vessels.*

But there is far more to these nozzles than meets the eye, for into their design goes a fund of technical information that is based on more than forty years of research and experience in dealing with the stresses in vessels and piping under pressure.

IN WeldELLS, too, there is more than meets the eye, for in WeldELLS and our other regular stock welding fittings is reflected this same accumulated "know-how"—this broad experience in designing and manufacturing for full strength.

An excellent example of this is the distribution of extra metal in WeldELLS where stress is greatest. Another, is the tangents which remove the weld from the zone of maximum stress. In fact, you will find evidence of adherence to highest engineering standards and complete mastery of manufacturing methods in all the features listed opposite—features that are combined only in WeldELLS.

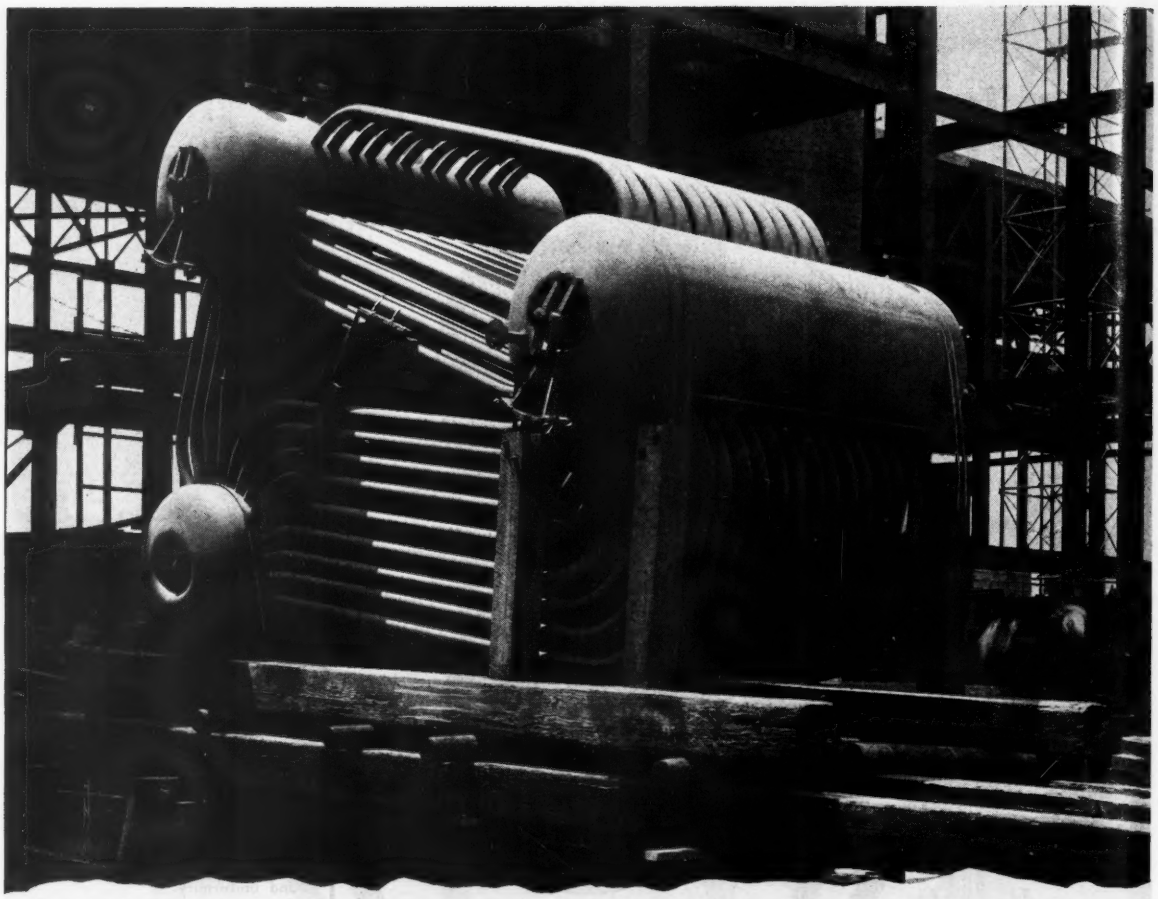
Check this list and we believe you will agree that:

WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility

WeldELLS have everything

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago P.O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.



Wickes 3-DRUM LOW HEAD BOILERS

Designed especially for installation where floor space and boiler room height are limited, Wickes 3-Drum Low Head Boilers are carefully engineered to effect maximum transfer of furnace heat into boiler energy at all ratings. Seamless steel or electric resistance welded tubes are bent to a long, easy radius to facilitate cleaning, and their arrangement permits convenient replacing when necessary.

Wickes 3-Drum Low Head Boilers are available in sizes up to 600 boiler horsepower and pressures up to 450 lbs. Class 1 welded construction. Solid, water-cooled, or air-cooled walls, as desired. Many sizes may be shipped completely assembled, and upon request Wickes engineers will supervise entire installation of boilers, brickwork, firing equipment, and all auxiliaries. Send us a sketch or description of your boiler needs. We will be glad to advise you how Wickes 3-Drum Low Head Boilers or other types of Wickes boilers will increase power efficiency in your plant.

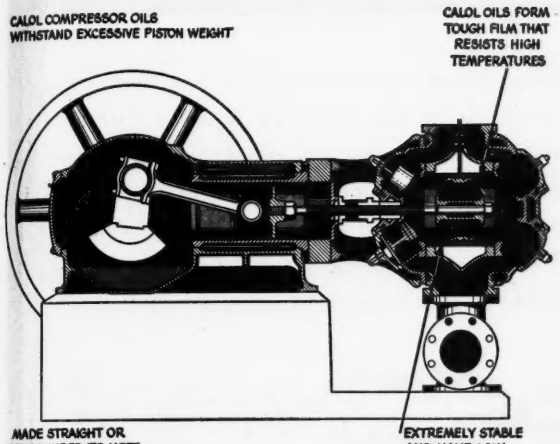
Wickes

THE WICKES BOILER COMPANY • SAGINAW, MICHIGAN • ESTABLISHED 1854

SALES OFFICES: Detroit, Mich.; Chicago, Ill.; New York, N. Y.; Milwaukee, Wisc.; Pittsburgh, Pa.; San Jose, Cal.; Tulsa, Oklahoma; Fort Worth, Texas; Mexico City, Mexico; Saginaw, Mich.; Portland, Oregon. Indianapolis, Indiana; San Francisco, California.

STANDARD ENGINEERS NOTEBOOK

CALOL RPM


CALOL COMPRESSOR OILS WITHSTAND EXCESSIVE PISTON WEIGHT
CALOL OILS FORM TOUGH FILM THAT RESISTS HIGH TEMPERATURES
MADE STRAIGHT OR COMPOUNDED TO MEET ALL CONDITIONS
EXTREMELY STABLE AND HAVE LOW CARBON-RESIDUE TESTS

SINGLE-STAGE AIR COMPRESSOR WITH OIL-TIGHT CRANKCASE

Special oils up air compressor efficiency

Many operators have increased air delivery from compressors by lubricating cylinders with specially-made Calol Compressor Oils.

To meet both dry and moist operating conditions, in all type compressors there are two grades. Both withstand high pressures and temperatures.

Calol Compressor Oil—19 is a straight mineral oil. Pale in color, it is very stable and correctly lubricates under pressures up to 150 pounds per square inch.

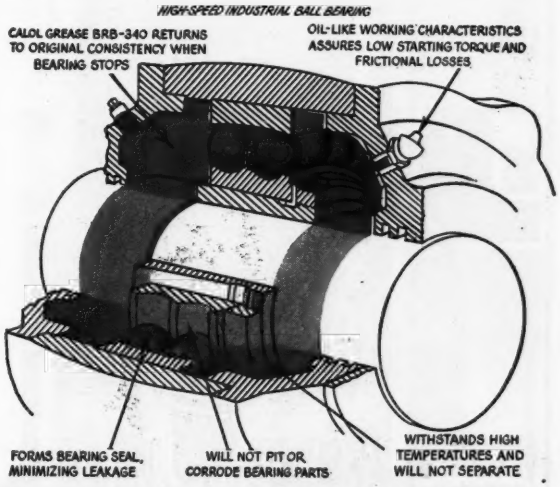
Calol Compressor Oil—19X is compounded and completely resists the washing action of moist air on the cylinders of machines operating in humid surroundings. It is particularly adaptable to large horizontal compressors, where piston weight is a factor, and to compressors on air-injection Diesel engines.

New Calol grease softens and resets

Where anti-friction bearings operate in severe conditions of temperature and speed, newly developed Calol Grease BRB-340 allows easy starting and reduces running friction to a minimum. At high shear rates, its apparent viscosity approaches that of its oil component. However, undue leakage from bearings is prevented by the peculiar ability of Calol Grease BRB-340 to reset, which causes the excess grease, swept aside by balls and rollers, to form a partial seal.

Calol Grease BRB-340 is soft, smooth and has a fine fibrous texture. It is milled by a special process that eliminates bleeding although it contains an unusual amount of oil stock.

When undergoing severe tests, Calol Grease BRB-340 showed no separation in a bearing operating 10,000 RPM at 200° F. for 528 hours. At the end of the test the bearing was in good condition.

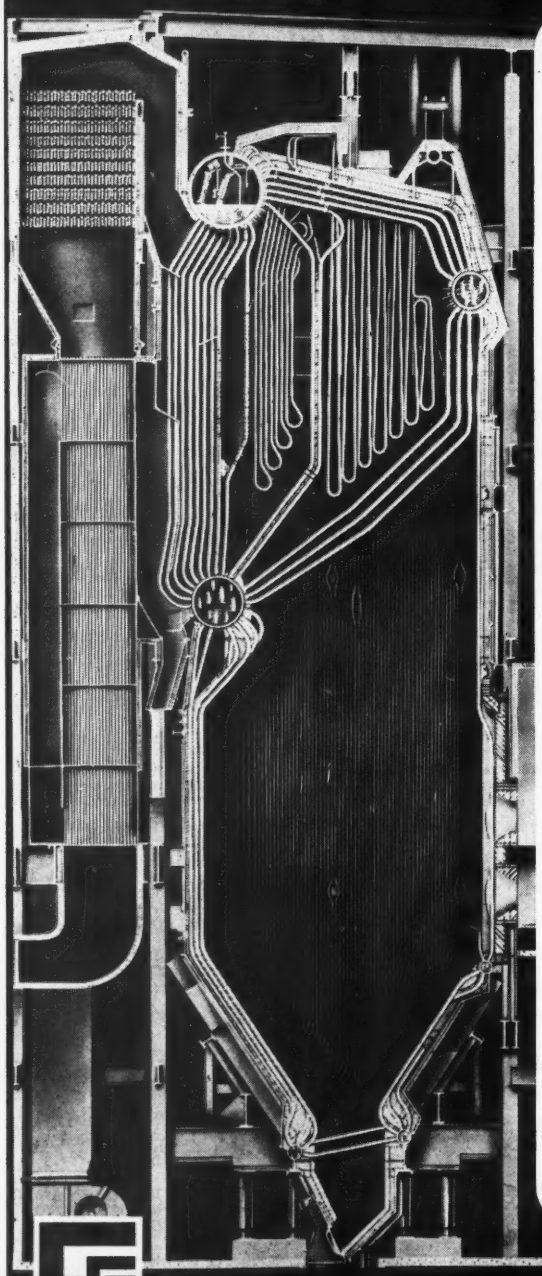

HIGH-SPEED INDUSTRIAL BALL BEARING
CALOL GREASE BRB-340 RETURNS TO ORIGINAL CONSISTENCY WHEN BEARING STOPS
OIL-LIKE WORKING CHARACTERISTICS ASSURES LOW STARTING TORQUE AND FRICTIONAL LOSSES
FORMS BEARING SEAL, MINIMIZING LEAKAGE
WILL NOT PIT OR CORRODE BEARING PARTS
WITHSTANDS HIGH TEMPERATURES AND WILL NOT SEPARATE

There is a Calol Product to meet every industrial lubrication problem. For information, write Standard of California, 225 Bush Street, San Francisco 20, California.

FOR EVERY JOB A STANDARD OF CALIFORNIA TEST-PROVED PRODUCT

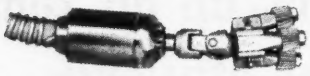
ROTO TUBE CLEANERS

For High Pressure, High Temperature RILEY Steam Generating Units



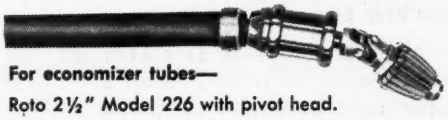
Riley Steam Generating Units are used in hundreds of the country's leading central stations and industrial plants. The high-pressure, high-temperature unit illustrated is one of their latest types. To help maintain this unit at top efficiency, the following Roto Tube Cleaner equipment is recommended:

For generating tubes and water walls—
Roto Senior 3¼" Model 125 motor with swing-frame head.



For generating tubes—
Roto 2½" Model 115 with 3-arm head.

For air heaters—
Roto 2" Model 105 with combination drill head.



For economizer tubes—
Roto 2½" Model 226 with pivot head.

Roto Tube Cleaners and accessories are now available for immediate delivery for practically any standard tubular equipment. Engineering assistance to meet special requirements will be furnished gladly. Write, wire or phone.

ROTO Division of ELLIOTT COMPANY
145 SUSSEX AVENUE - - - NEWARK 1, N.J.

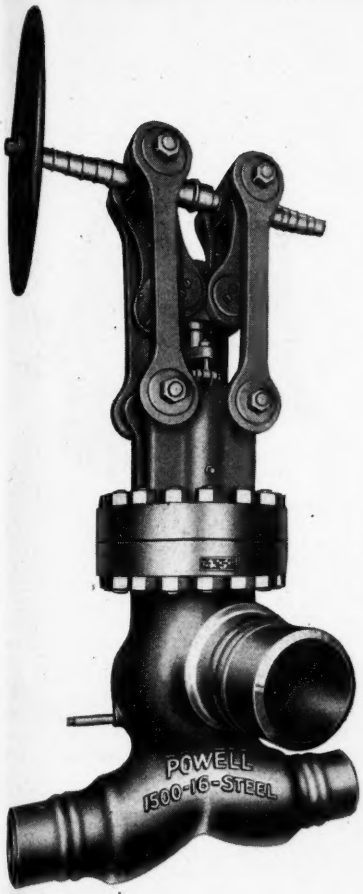
Safeguard your Boiler Installations with POWELL NON-RETURN VALVES

The primary consideration in the design and engineering of all Powell Non-return Valves is to insure the absolutely tight automatic closure so necessary to provide unfailing protection for your boiler installations. Body and bonnet structures are rugged and all parts are machined to perfect tolerances for the temperature limitations of the particular job involved. Chattering or fluctuation of disc level within the valve is reduced to a minimum.

Powell Non-return Valves are provided with thrust bearings or gears. Large sizes may be toggle operated, affording perfect manual control, if required. If desirable, electric motor operators for remote control can be provided.

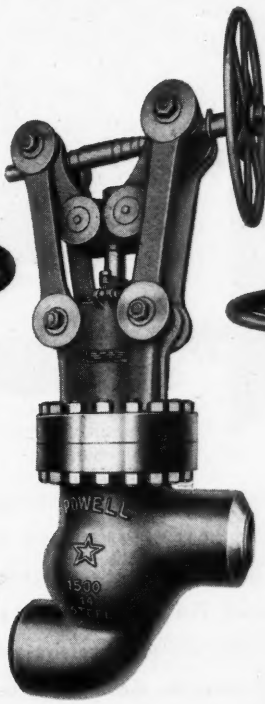
Today, many of the larger steam power and utility plants throughout the country rely on the unfailing performance of Powell Non-return Valves.

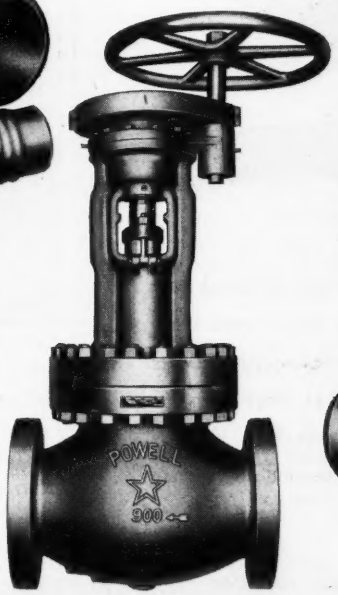
The Wm. Powell Company, Cincinnati 22, Ohio



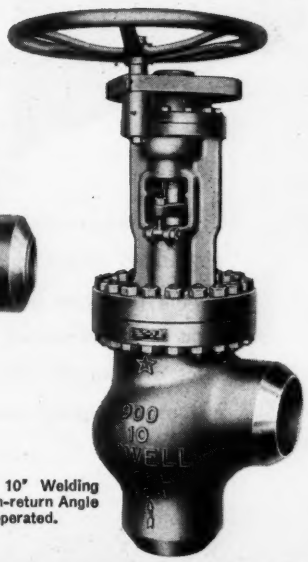
A Powell answer to the demand for higher pressure and higher temperature flow control equipment. This Class 1500-pound Cast Steel Non-return Angle Valve with welding ends, said to be one of the largest of its kind ever built, has 16" outlet and two 12" inlets. Because of special streamline designing the pressure drop through the valve is reduced to the minimum. Valve is toggle operated.

Class 1500-pound, 14" Welding End Cast Steel Non-return Angle Valve. Specially designed to meet certain specific requirements. Toggle operated.





Class 900-pound, Flanged End Cast Steel Non-return Globe Valve. Spur Gear operated.



Class 900-pound, 10" Welding End Cast Steel Non-return Angle Valve. Spur Gear operated.

POWELL VALVES

THE INSIDE DOPE ON DARTS

TWO BRONZE SEATS GROUND TO A TRUE BALL JOINT

INSIDE the practically indestructible body and nut (high-test air-refined malleable iron) of a Dart are two bronze seats ground to a true ball joint. That's what distinguishes Darts from *all other* unions. The perfect contact of these seats insures a leakproof joint without excessive wrenching; permits instant uncoupling whenever the union is needed for service elsewhere.

Ask your supplier

E. M. DART MFG. CO.
Providence, Rhode Island

DART UNIONS

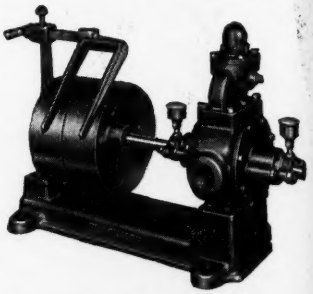
DART UNIONS LIVE LONGER

NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. Write to POWER PLANT ENGINEERING 53 W. Jackson Blvd., Chicago 4, Ill.

Self-Adjusting Solvents Pumps

A LINE OF flat-belt and direct motor drive rotary pumps in capacities from 10 to 750 gpm at pressures to 100 psi has been adapted to filter and transfer applications in dry cleaning plants by the Blackmer Pump Co., Grand Rapids, Michigan. The 10, 20, 35 and 50 gpm units are now in production and available for reasonably prompt



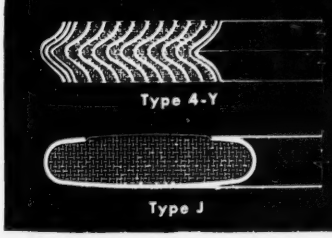
The pumps are designed to operate on the bucket design principle and because of this action are self-adjusting for wear. The buckets, or swinging vanes, move farther out of the recesses of the rotor as wear occurs at the tips. This compensating action maintains the normal capacity of the pump until the buckets are worn to the critical point, when they are replaced. To replace the buckets, the head plate of the pump is removed, the old buckets lifted out and new ones inserted. No adjustments are needed.

Tank Preheater

THE NEW BULK TANK preheater illustrated here has been developed by Rempe Co., 342 N. Sacramento Blvd., Chicago 12, Ill., for preheating heavy liquids in bulk storage. Many industrial users of fuel oil have found it necessary to buy the heavier lower grade oils which cannot be used with-

MODERN DEVELOPMENTS OF GASKET RESEARCH

BOILER GASKETS...



Standard Equipment with Leading Boiler Makers

Goetze Boiler Gaskets for handhole, manhole and tube caps are most inexpensive, highly efficient gaskets. They are used as standard equipment by leading boiler makers and are the outstanding preference of boiler operators. Type J Single-Jacketed, Metal-Asbestos Gaskets are available in a choice of metals — steel, copper, Monel, etc., for handholes and tube caps.

Goetze Type 4-Y Spiralwound — an improved Metal-Asbestos Gasket composed of interlocking plies of preformed metal, cushioned with asbestos strip and spirally wound, possesses unusual resilience — makes and maintains a perfect seal, even on badly-warped or pitted surfaces. This type is remarkably strong, highly resistant to corrosion and temperature, may be reused a number of times.

Made in plain or zinc coated cold-rolled low carbon steel and 18-8 Stainless Steel in round, oval or irregular shapes for manholes, handholes and tube caps.

GOETZE GASKET & PACKING CO., INC.
17 ALLEN AVENUE, NEW BRUNSWICK, N. J.
Boston New York Philadelphia Pittsburgh Cincinnati Cleveland Detroit Houston San Francisco Chicago Los Angeles Montreal

Technical Bulletins Available

Ask to have your name added to the list of engineers receiving "The Gasket" — a series of technical bulletins containing original gasket data emanating from the Goetze Research Laboratory. Write on your company letterhead giving your position.

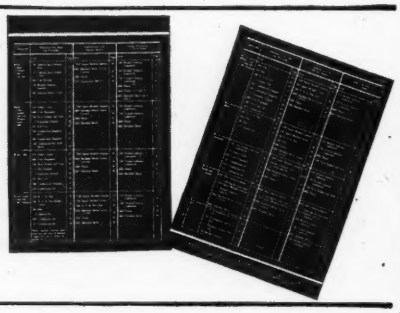
Goetze for GASKETS

"America's Oldest and Largest Industrial Gasket Manufacturer"

3 STEPS TO FEWER PACKING REPLACEMENTS

1. Make up your mind to put an end to power-wasting leaks and frequent time-wasting replacements.

2. Ask the Belmont distributor to show you the handy PACKING RECOMMENDATION CHARTS.



3. Standardize on the right Belmont packing at every point.

Belmont Distributors are located in every large industrial center, ready to serve you promptly from local stocks. Get the PACKING RECOMMENDATION CHARTS from the one nearest you — or send the coupon to us.

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

on the blue-and-orange box

THE BELMONT PACKING AND RUBBER COMPANY
Butler & Sepviva Streets, Philadelphia 37, Pa.

Gentlemen: Please send PACKING RECOMMENDATION CHARTS for the services checked:

☐ Steam . . . ☐ Hot Water . . . ☐ Cold Water . . . ☐ Brine . . . ☐ Ammonia . . .
☐ Acids & Caustics . . . ☐ Air . . . ☐ Gas . . . ☐ Oil . . . ☐ Gasoline . . .
☑ Asphaltic & Tar Products . . .

Name .....
Company .....
Address .....

out preheating. Oil flows more freely at higher temperatures and burns more efficiently.

This preheater can be made to fit any size tank having a manhole 16-1/2-in. or larger. It is installed by cutting or drilling holes for pipes in manhole of the tank. Thirty-eight square ft. of direct radiation surface, plus 10 sq ft of secondary shell heating surface is provided.

It is provided with a flow accumulator which makes it necessary for liquids to flow over the coils before entering the suction line thus preheating is assured.

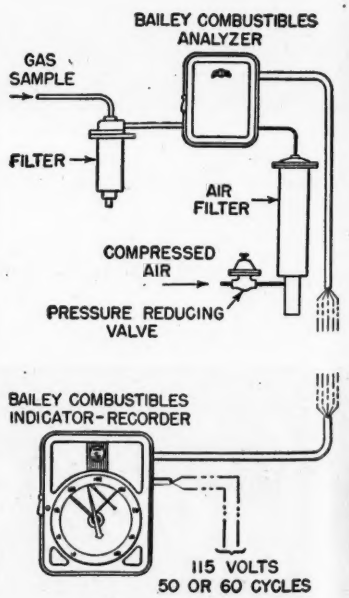
Built for use with steam or hot water as desired by providing proper size inlet and outlet pipes at time of fabrication. The coil is 1 1/2-in. standard steel pipe. Shell is 12 gage sheet steel—16-in. O. D. Accumulator is steel construction bolted in place. Complete unit tested with 400 psi air pressure under water after fabrication. Pipes made proper length for each installation.

Combustibles Recorder-Controller

A NEW AUTOMATIC analyzer and recorder for indicating, recording and controlling the combustibles content of a gaseous mixture, has been developed by the Bailey Meter Co., Cleveland 10, Ohio. This instrument has been successfully applied to precision control of furnace atmospheres and chemical processes, as well as combustibles measurements in the petroleum, metallurgical, automotive, and chemical industries.

The analyzer and recorder provide a continuous graphic analysis almost instantly, and they are said to be responsive to changes of 0.05 per cent combustibles. Sustained accuracy is said to be within 0.25 per cent.

In operation, a continuous gas sample is mixed with compressed air and burned on a catalyst-filament which reaches a temperature proportional to



Specialists IN STEEL CASTINGS FOR VALVES—FITTINGS

• A sharp upswing in temperatures and pressures began nearly half a century ago. The need for cast steel valves and fittings became apparent. And that's when Reading began to specialize in *pressure* steel castings.

Early development was a matter of experimenting, recording experience and studying the records. But, as pressures and temperatures continued to rise, the demand was for ever higher standards in valves. Reading met the challenge with improved manufacturing methods. Melting processes were refined from converters to open hearth furnaces, then to electric furnaces. Control and investigational methods, such as photomicrographs, radiography, new methods of sand-testing and slag control were developed and improved.

Such developments produced castings in either carbon steels or alloys to use in valves to meet today's exacting requirements—valves and fittings which safely and reliably handle present-day high temperatures in the steam services and the gases and oils of the petroleum industry.

R-P&C offers you a single responsible source for bronze, iron and steel gate, globe, angle and check valves—cocks and Lubrotite gate valves—bar stock valves—cast steel fittings—D'Este Automatic Regulating Valves.

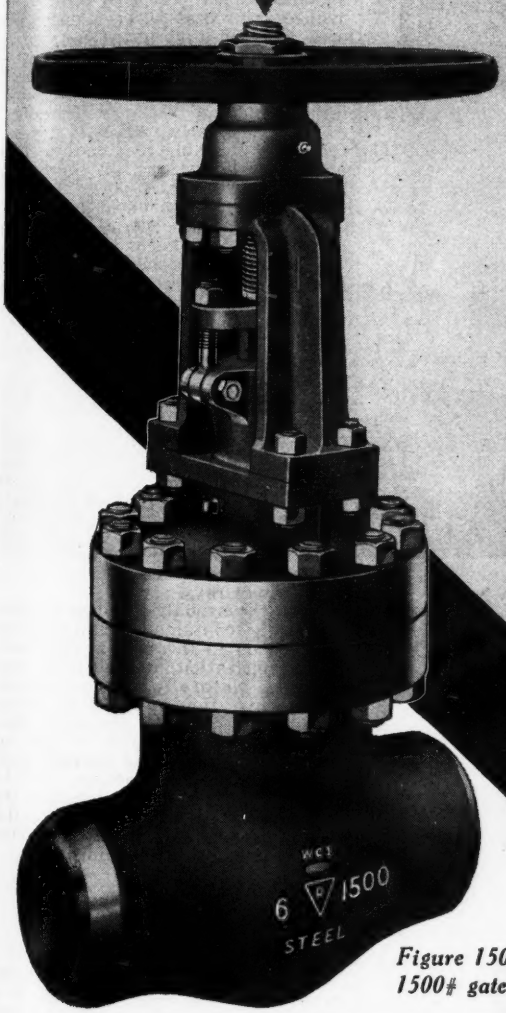


Figure 15004
1500# gate valve

READING-PRATT & CADY

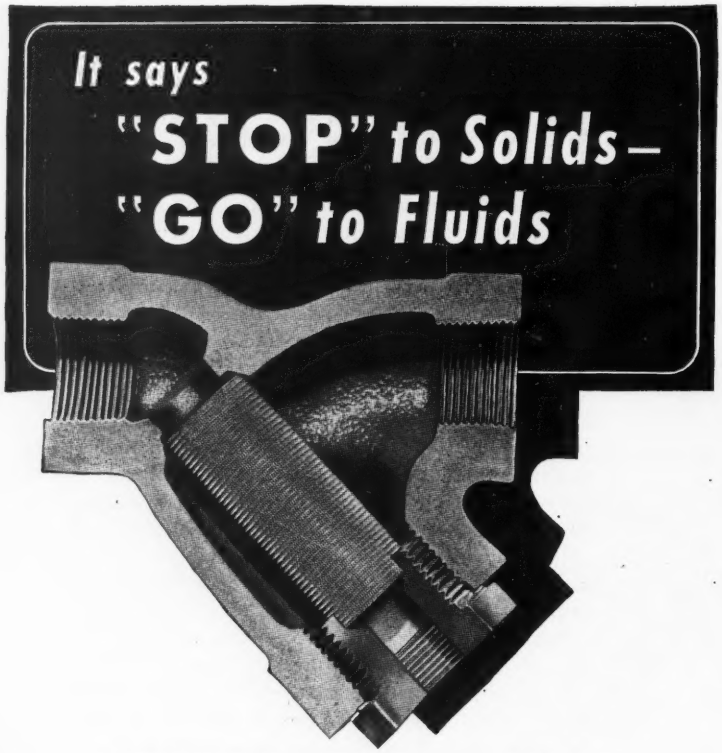
MANUFACTURERS OF
READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE AUTOMATIC REGULATING VALVES

ACCO

Reading, Pa. • Atlanta • Chicago • Denver • Detroit • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Bridgeport, Conn.

READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK



A BETTER Strainer to "police your pipelines"

- **FIRST**—*The Screen*, a high-grade woven Monel wire basket that catches solids—lets condensate, oil or other fluids flow freely.
- **SECOND**—*Finish*. Cadmium plated inside and out for protection against corrosion.
- **THIRD**—*Easily Cleaned*. Blow-off bushing made for easy removal. Bushing and Screen come out together. Screen automatically aligns on reassembly.
- **THOUSANDS IN SERVICE**—Sold by over 100 Mill Supply Houses.

6 sizes from ½" to 2" for pressures up to 600 lb. Reasonably priced. See your supply house or write for Bulletin S-200.

YARNALL-WARING COMPANY
114 Mermaid Ave. PHILADELPHIA 18, PA.

the combustibles content. Since the filament resistance is a function of temperature, a simple resistance bridge connected to a null-balance electronic recorder completes the installation. It may be calibrated in per cent combustibles, mixture ratio, or other desired terms.

Pneumatic control or electric alarm contacts may be provided on both one and two-pen recorders. A two-pen recorder utilizes separate analyzers so that the speed is not impaired by switching, and the two records are independent of each other.

Combustibles recorder-controllers applied to process furnaces operating with reducing atmosphere are said to permit finer measurement and control than has heretofore been considered possible. This results in greater uniformity and higher quality of product, as well as greatly increased furnace economy. Variable fuel quality does not affect the accuracy of control on installations of this type.

Plants in the chemical industries, as well as other operations having processes where gases contain combustibles, find the continuous graphic analysis of this recorder to be a valuable addition to their instrumentation.

Asphalt-Aluminum Roofing

NEW ROOFING MATERIAL has been developed at the A. C. Horn Co. laboratories, 43 Tenth St., Long Island City 1, N. Y., combining asphalt coating with practically pure aluminum. Each particle of asphalt was provided with its own bright metallic reflector to throw back the destructive ultra violet rays.

Both the asphalt coatings and the integrally contained aluminum are brushed on to the roof at one time, in one operation for one successful purpose. Naturally and fortunately, some separation takes place when the law of specific gravity works. The asphalt sinks down to take up its bad weather job of protection at the bottom of the coating, next to and bonded to the roof, whereas the aluminum stays at the top facing the sun and reflecting back its rays. This Horn product is called Hornlume.

Pressure Sensitive Instrument

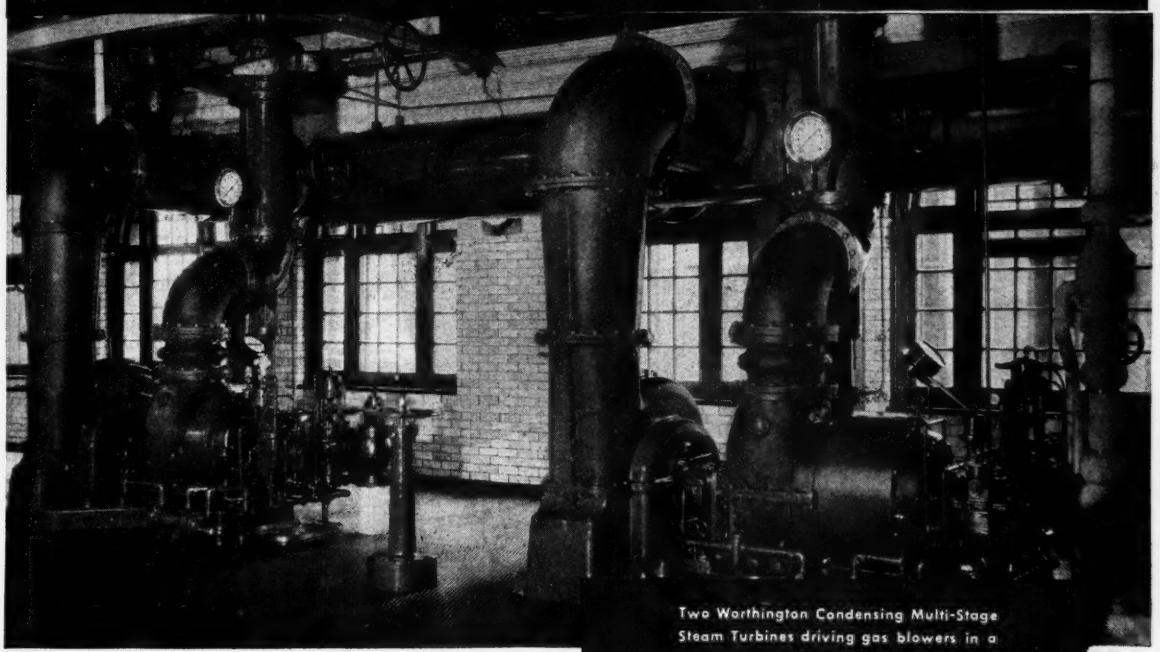
BALDWIN LOCOMOTIVE WORKS, Southwark Division, has developed a pressure sensitive device utilizing the principle that the electrical characteristics of a wire filament change with a physical strain.

The new instrument, called the SR-4 Pressure Sensitive Device, is used to convert gas or liquid pressure to electrical energy for measuring, recording or controlling. Its extreme accuracy, one-fourth of one per cent of full scale having been consistently obtained, will mean that the device can be used for control operations that heretofore have not been possible. It is available in several ranges up to 0-to-20,000 psi.

Since it is essentially an electronic device it will enable results to be transmitted long distances whether for direct reading, recording or con-

MORE POWER FROM YOUR STEAM

. . . with Worthington Multi-Stage Turbines



Two Worthington Condensing Multi-Stage Steam Turbines driving gas blowers in a large utility.

You will want to investigate Worthington Multi-Stage Steam Turbines for either condensing or non-condensing service. Worthington's familiarity with all phases of steam power and specialized knowledge of Steam Turbine engineering account for *low maintenance* and *smooth, dependable economic operation.*

Low steam consumption is inherent in the design of these turbines, built in sizes from 100 HP to 10,000 HP for operation on high or low pressure steam and for speeds up to 9000 RPM. For full descriptive literature, write *Worthington Pump and Machinery Corporation, Harrison, N. J.*

WHO USES THEM?

Worthington Multi-Stage Steam Turbines—condensing and non-condensing types — are now driving blowers, generators, pumps, line shafts, refrigeration compressors, air-conditioning units, paper machines, cane shredders, etc. Data that proves *there's more worth in Worthington* is available on request.

WORTHINGTON

TS-1

A GREAT TEAM IN STEAM

FULLER ROTARY COMPRESSORS
BUILT FOR CAPACITIES TO 1800 C.F.M. PRESSURES TO 125 LB. VACUUMS TO 29.00 IN. REFERRED TO 30-IN. BAROMETER
AND VACUUM PUMPS
"SPOT" YOUR COMPRESSORS
FULLER
FULLER COMPANY

Why — compress air to 100-lb. when lower pressures will do the work?

There is no necessity to continue the old practice of compressing air at a central point with large-size, high-pressure units working on pressures equal to the highest demands from any part of the plant. It is costly to compress air to a hundred pounds or higher, and then reduce it to from 10 to 50 pounds for any one particular use.

You can eliminate this costly practice by the installation of Fuller Rotary Compressors. *"Spot your compressors where you need the air."*

Single-stage compressor shown above is one of 14 installed in a single plant, each "spotted" as close as possible to the point of utilization of the air.

Bulletin C-5 illustrates and describes these machines. It's yours for the asking.

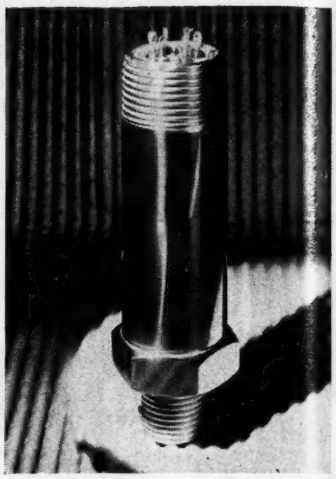
FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

Chicago 3 · 1144 Marquette Bldg.
San Francisco 4 · 421 Chancery Bldg.
Washington 5, D. C. · 618 Colorado Bldg.

No. 2 of a series

C-110

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS



trol. Transmission even by radio is feasible. This will eliminate the leakage and clogging troubles in conventional capillary tubes used with other pressure sensitive instruments.

The heart of the device is a very fine filament wire bonded to a hollow metal core against which is exerted the gas or liquid pressure to be measured. As the pressure increases this filament stretches, thus changing the diameter of the wire and causing measurable changes in the electrical resistance of the wire. This change in resistance varies the amount of current flowing through the filament circuit and, when amplified, these changes show up on the dial or are used to actuate a control system. The filament is sensitive to a "stretch" of the metal core of only one-millionth of an inch. It is this ability to measure great changes in pressure without any physical movement that has led to a description of the instrument as being actuated by the "breathing" condition of the metal.

The SR-4 Pressure Sensitive Device is hermetically sealed and built-in compensator cancels out the effect of any extraneous force such as temperature. It is approximately one inch in diameter and five and one-half inches in length.

Among the numerous industries where the device should prove to have valuable applications would be in steel mills, refineries, hydro-electric plants, oil well operation, gas and oil pipe lines, filtration plants and other public utilities, chemical plants and processing plants such as paper mills, food processing and plastics.

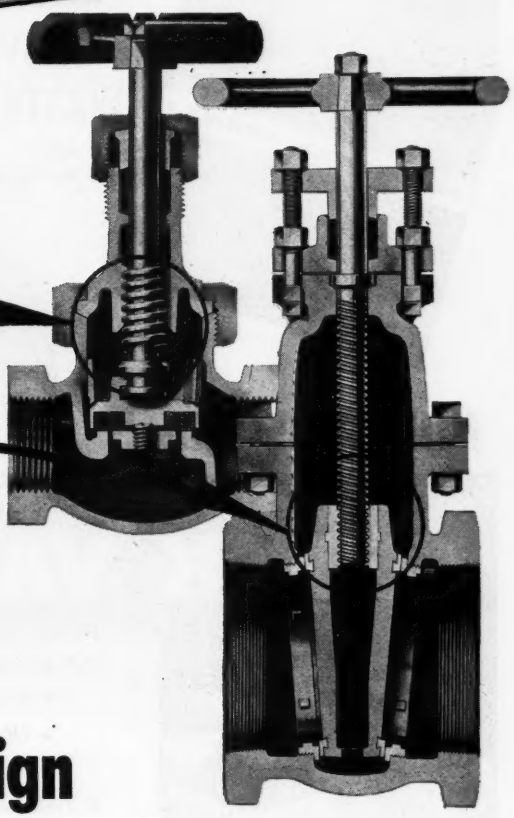
Direct-Fired Heaters

PRODUCTION OF A NEW line of direct-fired heaters for commercial and industrial applications is announced by the Herbert H. Davis Co. of Cicero, Ill. The heaters range in capacities of 75,000 to 2,000,000 Btu. output per hour and are available for all types of fuel—oil, gas and coal. The units are made entirely of steel; are completely self-contained; are equipped with fully automatic control systems; and lend themselves to a wide variety of installations,

"Trifles make perfection but perfection is no trifle"

One of a series of advertisements explaining how Kennedy gives careful attention to the details of valve design, construction and workmanship that provide maximum effectiveness, convenience, and length of service.

Contact



..one of the many surfaces "strong ~~points~~" in KENNEDY VALVE design

It is customary to speak of an advantageous feature as being a "strong point". But the contact between the stem threads and bonnets or discs of Kennedy Valves is far more than a *point* of strength... it is a *surface* of strength...made so by the unusually large number of heavily proportioned contact threads.

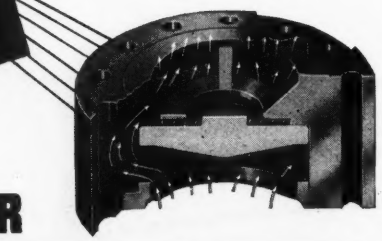
As a result, stripping of threads is practically impossible . . . another detail of Kennedy design that assures long, satisfying service with minimum maintenance expense of every Kennedy Valve.

Write for the Kennedy Catalog which explains in detail why you are SAFE when you standardize on Kennedy Bronze and Iron Body Valves for every standard requirement.

The Kennedy Valve Mfg. Co., Elmira, New York

KENNEDY valves...pipe fittings...fire hydrants

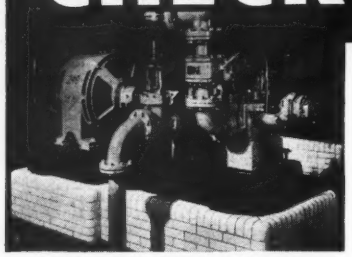
THIS NEW INFORMATIVE CATALOG WILL SOLVE YOUR "WATER HAMMER" *Problem!*



WILLIAMS-HAGER

FLANGED *Silent*

CHECK VALVES



A Williams-Hager Valve in the Metropolitan Life Building, New York.

- *Precision Engineered*
- *Economical*
- *Efficient*
- *Frictionless*
- *Tight Under Every Operating Condition or Pressure up to 6000 Lbs.*

Williams-Hager Flanged Silent Check Valves completely eliminate "Hammer" and "Bang" in the lines, provide uninterrupted constant flow of liquids.

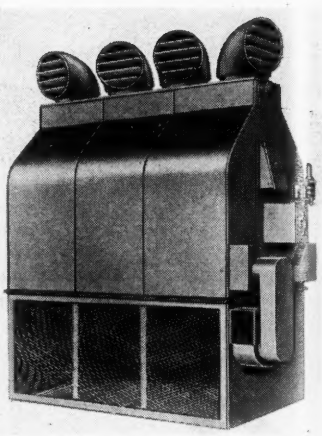
Unlimited in size or application, from 1" to 20", built of materials to best suit the end use, Williams-Hager Flanged Silent Check Valves have been chosen for years as standard equipment in such exacting line uses as oil, gasoline, acids, water, chemicals, gas, air, salt water, brine, etc., regardless of temperature.

Write today for YOUR copy!

THE WILLIAMS GAUGE COMPANY

Pump Valves . . . Water Gauges . . . Gauge Cocks . . . Pump Governors . . . Steam Traps Feed Water Regulators . . . Water Columns

3000 PENNSYLVANIA AVENUE · PITTSBURGH 12, PA.

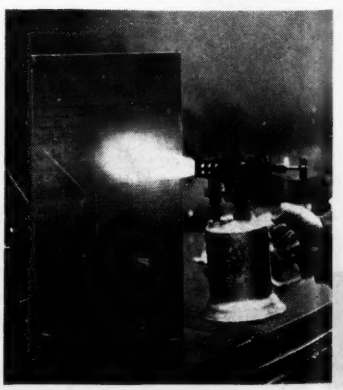


either for air distribution direct through rotatable diffusers or through ducts. In the design, some of the more important new features are: (1) unit is shipped in two sections. This makes possible unloading and placing without heavy crane facilities, entry through much smaller building openings, and shipment to any part of the United States by truck; (2) filters may be applied without special transformations requiring additional floor space; (3) lower resistance through heater provides quieter fan operation and lower motor horsepower; (4) tubes may be cleaned while standing on floor; (5) occupy less floor space; (6) independent V-belt driven induced draft fan; (7) self-contained automatic thermostatically controlled humidification.

Plastic Glass Panels

A NEW PLASTIC-GLASS panel, developed by Westinghouse Electric Corp., East Pittsburgh, Pa., for electrical control boards on Navy ships which cuts down dangers to equipment and men in case of fire is now being used on board U. S. fighting craft. The new material, called glass Melamine Micarta, is claimed to be more resistant to shock than the previous types used, and it is far more fire-resistant than the equipment it replaces because, when heated, it produces nitrogen, an inert gas that smothers flames.

The new form of Micarta is made of glass cloth bound together with a resin binder of the Melamine class,



We need four hands

TO POINT OUT THE MAJOR FEATURES OF THIS MOTOR

But *you* need only one head . . . and two minutes . . . to appreciate these design advantages of the *new* Crocker-Wheeler Protected-Type Motor.

1. Frame and shields have no openings above the horizontal center line, which means that dripping liquids, falling metal chips, etc., can't get inside the motor to damage the interior working parts.

2. *Vinylastic* insulation makes coils dirt, oil and moisture resistant to a high degree. Phase insulation provides added protection. Treatment in thermo-setting varnish lengthens insulation life and prevents destructive vibration of coils.

3. Bars, fans and end rings of *Alucast* rotor are die cast in one operation from aluminum alloys, forming a practically indestructible rotor. All rotors are dynamically balanced to assure smooth, vibrationless operation.

4. Patented bearing seal for ball bearings (sleeve bearings are optional) is so effective that regreasing is required only once a year or even less frequently, hence maintenance expense is negligible. This seal permits use of softer grease, for better lubrication and longer bearing life.

Write on your company letterhead for a FREE copy of descriptive bulletin DL-121, which tells where these motors should be used. Or if you prefer, one of our field engineers will be glad to help you decide whether this is the type of motor you need. Write today . . . no obligation.

THESE COUPLINGS HAVE UNIQUE FEATURES, TOO!

The Crocker-Wheeler resilient flexible coupling consists of a spider, a flange, a ball retaining cover and six synthetic rubber balls—that's all there is to it! And yet, this is more than just a trouble-free coupling—it actually adds years to the life of both the driving and driven machines.

The balls transmit torque, absorb shock and vibration, yet do not transmit end thrust. Available for shaft diameters up to 8", these couplings require no lubrication, no maintenance of any kind. Write for complete information.

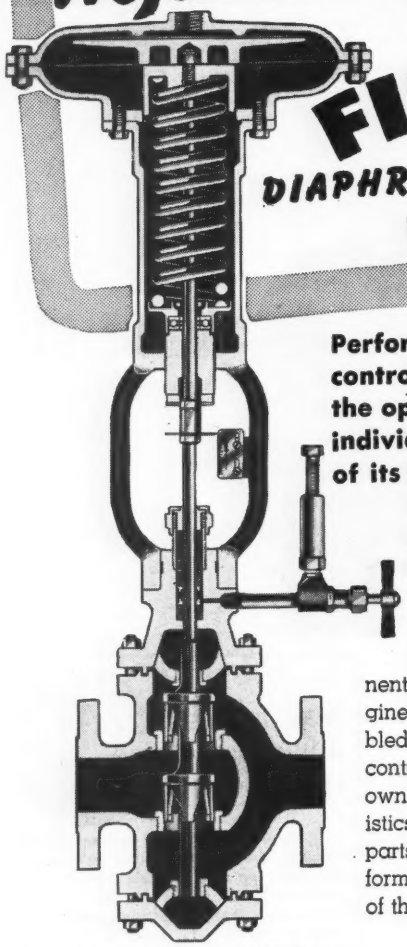
CW-4

CROCKER-WHEELER

A DIVISION OF JOSHUA HENDY IRON WORKS, AMPERE 28, NEW JERSEY

Branch Offices: BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • LOS ANGELES • NEW YORK • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • WASHINGTON

Preferred Performance WITH FISHER DIAPHRAGM CONTROL VALVES



Performance of a diaphragm control valve is dependent on the operating characteristics, individually and collectively of its three component parts —*Diaphragm Motor, Inner Valve, and Valve Body.*

Fisher Diaphragm Control Valves incorporate component parts that are correctly engineered, machined and assembled to function as a complete control unit. Each part retains its own required operating characteristics yet collectively the three parts assure the preferred performance characteristics required of the complete unit.

DIAPHRAGM MOTOR

(1) Large area sensitive diaphragms. (2) Spring designed to avoid over stress — accurately calibrated. (3) Friction or hysteresis minimized. (4) Performance characteristic—straight line relation between pressure to diaphragm vs. stem stroke.

INNER VALVE

(1) Proper characteristic by correct contour designs and by close control of port contour machining. (2) Selected materials for resistance to corrosion, erosion and galling. (3) Skirt guided or top and bottom guided — conventional throttling or percentage type characteristics.

VALVE BODY

(1) Large flow passages minimize friction losses. (2) Full port openings develop full line area. (3) Distance between ports avoid inner valve interference to flow. (4) Wall section built to ASA standard — iron bodies 250 lbs. — steel bodies 600 lbs. regardless of end fittings. (5) Deep packing stuffing box with molded packing and lubricated.

FISHER GOVERNOR COMPANY
1029 Fisher Bldg., MARSHALLTOWN, IOWA

a cyanamid base synthetic. This resin binder was used for surfacing plastic panels made for refrigerators before the war. When it is used as a binder with the glass cloth, an inorganic substance, the two together make a practically fireproof material.

In addition, the continuous length of the fibers in the glass cloth gives the new material great strength against sudden blows or concussions that are likely to be experienced aboard a naval vessel in time of war. Production of the Melamine Micarta panels was worked out by plastic experts at the Westinghouse Micarta Division.

One of the production problems was the making of a uniform bond throughout the new panel. It was found that the starch and oil coating used to protect the glass fibers for manufacture and handling caused the trouble. The cloth was then preheated to caramelize this coating and thus a better bonding surface was found. This treatment gave twice the bonding strength and better physical qualities.

Layers of glass cloth, coated with Melamine resin, are plied to the proper thickness, then pressed and heated for polymerizing the resin around the fibers into a new composite panel material.

Cleaning Compound

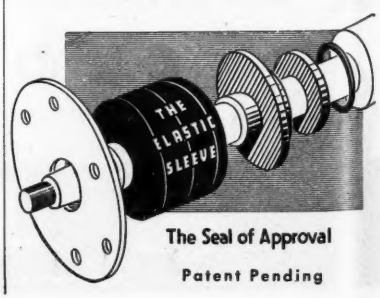
A BASICALLY NEW three-function chemical development having deodorizing, cleaning and germicidal properties is announced by Oakite Products, Inc., 18C Thames St., New York 6, N. Y. The material, Oakite Tri-San, is a white powder, which is dissolved in water and applied to surfaces in the same manner as any cleaning agent.

Primarily designed to simplify plant hygiene procedures, the material, due to its germicidal and fungistatic activity, is reported to be highly effective in controlling and preventing growth of spores and mold organisms often found on surfaces of walls, ceilings, floors.

Elastic Sleeve Seal

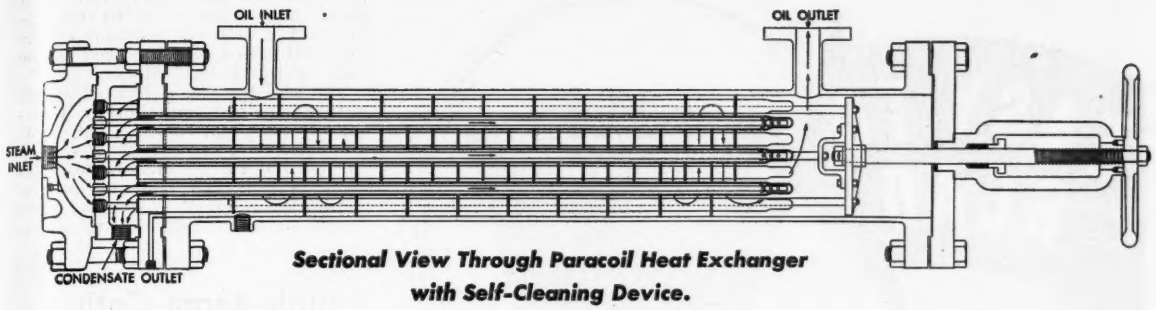
FOR CENTRIFUGAL, ROTARY, RECIPROCATING, and any other pumps using rotating shafts that must be sealed, the Temperature Control Devices, New Haven 15, Conn., has developed the Elastic Sleeve seal.

The Elastic Sleeve is at present being manufactured for use with new compressors and as a replacement seal for old. It has been proven that they work equally well on bent, pitted, or slotted shafts and elimi-



The Seal of Approval

Patent Pending

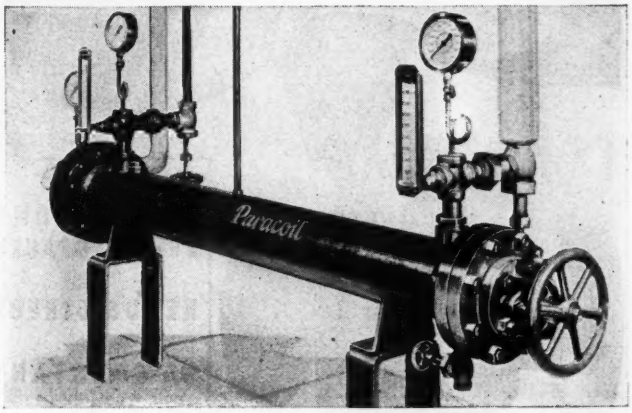


Sectional View Through Paracoil Heat Exchanger with Self-Cleaning Device.

Paracoil

HEAT EXCHANGERS

Built to do a better job



By moving the hand-wheel clockwise and counter-clockwise the entire baffle-assembly is moved back and forth over the heating surface thus scraping any deposits from the tubes. Cleaning action is positive and effective.

ONE OF THE MANY special features available in Paracoil Heat Exchangers is the Paracoil Self-Cleaning Device.

Illustrated is a Paracoil Fuel Oil Heater installation made in a well-known manufacturing plant in 1941. Previously this plant used two straight tube, multi-pass type heaters with the oil in the tubes and the steam in the shell. To maintain oil temperatures necessary for proper combustion and freedom from smoking, approximately sixteen man-hours were used to clean them mechanically approximately *every ten days.*

It will interest plant executives to know that since the Paracoil Oil Heater was installed its Self-Cleaning Device has *eliminated the necessity for this mechanical cleaning* and has kept the heating surface free from fouling without the slightest loss in oil temperature.

Used regularly and periodically, as required by the quality of the oil and the conditions of operation, the Paracoil Self-Cleaning Device permits the prevention of accumulating fouling deposits which decrease heat transfer rates with resulting lowered oil temperatures, and in many cases, inefficient operation.

Two heaters of this same type were installed by a large paper plant for the heating of white water, replacing equipment which required disassembling for tube cleaning *almost every day.* These Paracoil Heat Exchangers with the Self-Cleaning Device have been and are now operating for long periods without this costly disassembly for cleaning.

Paracoil Heat Transfer Equipment is built with *every required factor* of modern heat exchanger design and efficiency.

Every Paracoil Heat Exchanger can be depended upon for uniform operating performance, exceptional economy, rugged construction and long life.

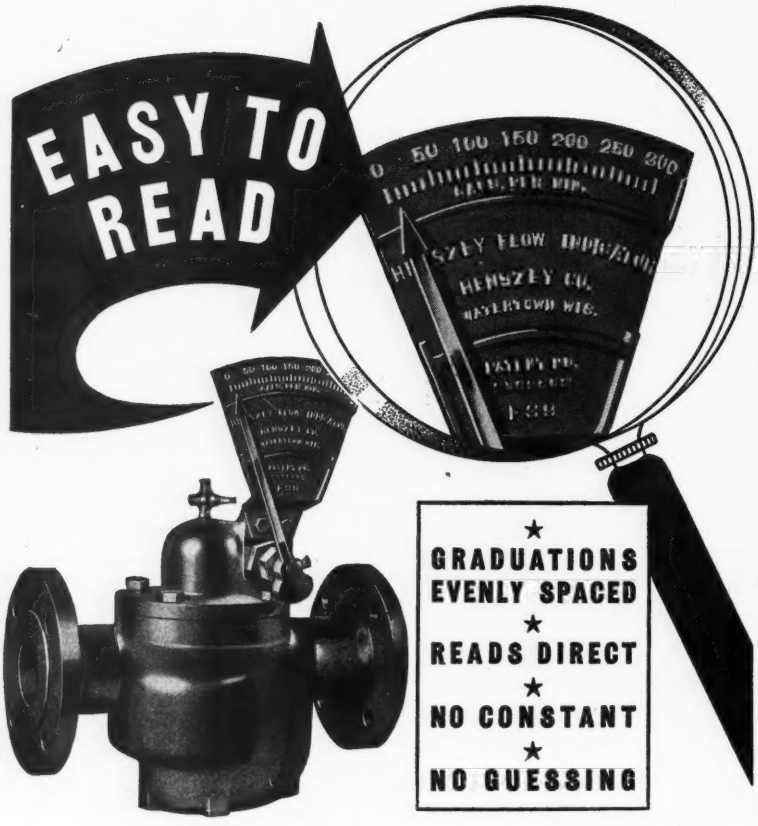
Paracoil Heat Exchangers with other special and exclusive features are available in a wide range of standard equipment. If required, special units can be designed by Davis Engineering Corporation for any heat transfer requisite.

To help you improve your plant efficiency in postwar production, our engineers are at your service to guide you in the selection of proper heat exchange equipment for your specific needs.

Write for Bulletin H-100 describing the Paracoil Self-Cleaning Tubular Heat Exchanger.

SINCE 1915
Paracoil
HEAT TRANSFER EQUIPMENT

DAVIS ENGINEERING CORPORATION
1068 EAST GRAND STREET, ELIZABETH 4, NEW JERSEY



HENSZEY FLOW INDICATOR

To know the rate of flow at any one instant, at any time, requires a flow indicator that is accurate and easy to read — like the Henszey Flow Indicator. This rugged instrument goes right in the line and indicates the flow accurately from zero to 100 per cent — indicating a pulsating flow exactly as it occurs.

With only three moving parts, the Henszey Flow Indicator stays on the job — breakdowns due to complicated mechanisms and gears are eliminated.

Henszey Flow Indicators are satisfactorily performing in nationally known paper mills, chemical plants, petroleum refineries, milk condenseries and other vitally important industries.

Send for Bulletin FI-1

HENSZEY CO. Dept. C11 Watertown, Wis.

HENSZEY

FLOW INDICATORS

Continuous Blowdown • Distillation Systems • Heat Exchangers
Feed Water Meters • Boiler Feed Regulators • Proportioning Valves

nate all springs, shins, and shaft glands due to the perfected development of a new oil resistant elastic material which is being used as the body of the Elastic Sleeve.

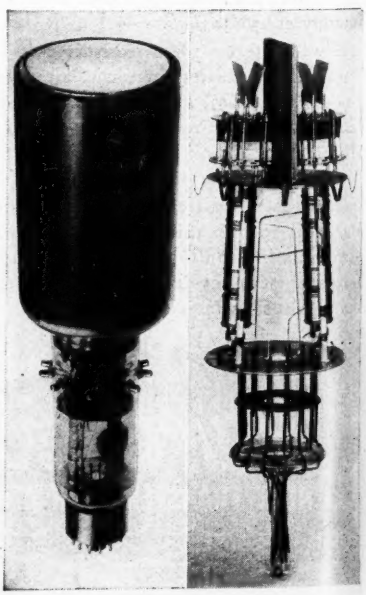
The seal bearing is located at the source of oil supply thereby assuring proper lubrication. The new, simplified design which has been worked out for all modern installations enables faster installation due to fewer assembly parts with no fragile parts to break during assembly.

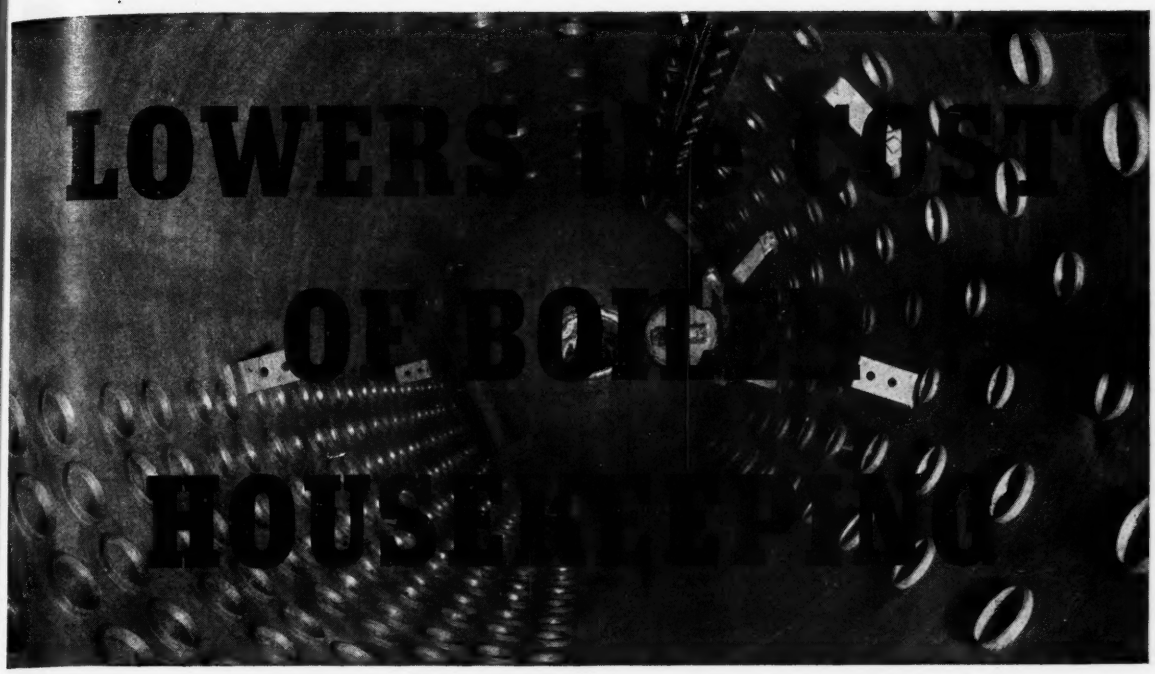
Double-Beam Cathode-Ray Tube

THE DU MONT TYPE 5SP double-beam cathode-ray tube now made available by Allen B. Du Mont Laboratories, Inc., of Passaic, N. J., provides two complete "guns" in a single glass envelope, both aimed at or converging on the single screen for simultaneous and superimposed traces.

Heretofore the simultaneous comparison of two phenomena could be accomplished either by using two separate tubes or oscillographs placed side by side, or by using an electronic switch in order to present first one phenomenon and then the other on the same tube screen in rapid succession. The former method, however, is obviously unwieldy and does not permit the superimposing of traces for accurate comparison, while the latter has limitations caused by the frequency response and the switching rate of the electronic switch, as well as the inability to use independent time bases or sweeps.

With this new double-beam cathode-ray tube the previous limitations are removed. The two independent "guns" are contained in a 5-in. envelope. There is complete and independent control of the X, Y and Z axis functions for each beam. Adequate shielding between "guns" and "plates" minimizes "cross-talk" par-





APEXIOR NUMBER 1 brings economy to boiler maintenance by:

1. preserving metal surfaces under the coating
2. preventing direct bonding of dirt or scale
3. reducing the labor of boiler maintenance
4. sealing off water-contact at all joints

In cooperation with proper feedwater treatment, APEXIOR NUMBER 1 successfully combats corrosion at its source. It is recommended by all boiler insurance companies in the United States and Canada. If desired, all boiler manufacturers will quote on the preparation of drums and tubes and the application of APEXIOR, under Dampney Company supervision.

FOR "COLD-WET" METAL

APEXIOR NUMBER 3 is the counterpart of APEXIOR NUMBER 1 for preserving and simplifying the maintenance of metal subject to contact with cold water, either salt or fresh. Non-toxic, it can be used for potable water tanks, feedwater tanks, condensers, cooling towers, etc., where temperatures do not exceed 125°F.

Repeat Users Like These Have Used APEXIOR for Years

Vanderbilt University
Tide Water Associated Oil Co.
Southwestern Public Service Co.
Morton Salt Company
Minnesota & Ontario Paper Co.
Connecticut Light & Power Co.
Kaiser Company, Inc.
Detroit Edison Company
Chemical Warfare Service
Bethlehem Steel Co.
Amalgamated Sugar Co.
Utah Canning Company

APEXIOR

Keeps new metal new . . . Gives old metal new life

DAMPNEY

THE DAMPNEY COMPANY OF AMERICA
Hyde Park, Boston 36, Mass.

Please send free Bulletin 1290.

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Company.....

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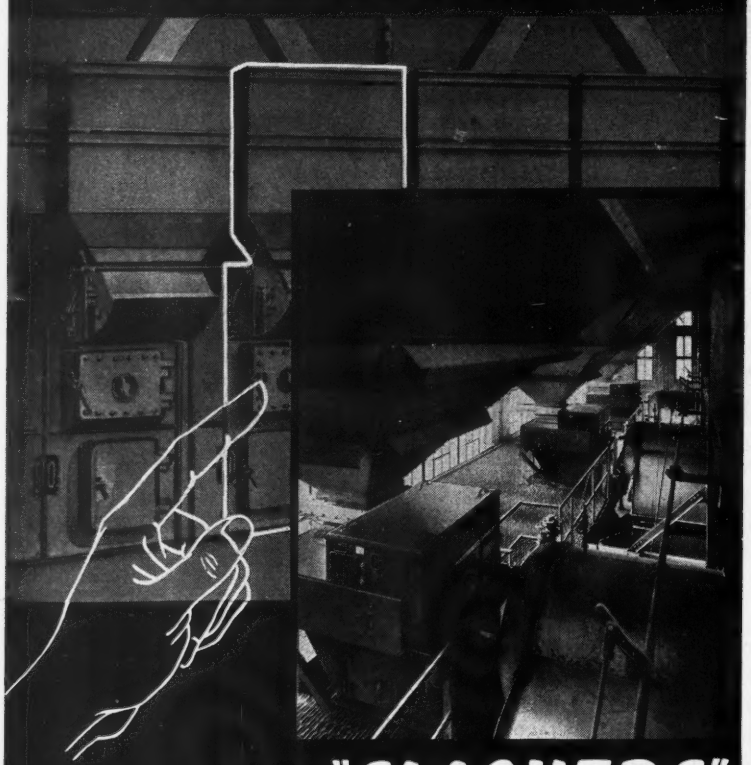
GET RICHARDSON COAL SCALES



to point out the "SLACKERS"

HERE'S a way to check for—and keep getting—maximum efficiency from new or revamped boilers and turbines . . . a way that helps you get every B.t.u. and kw.-hr. of which they are capable:

Spot possible losses, *right at the source* . . . with a Richardson Coal Weighing, Conveying and Feeding System that weighs and records every pound of coal burned, so that boiler performance—evaporation rates—and similar factors—are definitely known.

The heart of the Richardson System that gives you indisputable records is the Automatic Coal Scale. It puts the finger on the "slacker" boiler because if any boiler in a battery is burning more coal than its mates, under the same conditions, it's pretty certain something is wrong with that boiler. Richardson Scales automatically weigh and register the coal consumed per hour, per shift, per day—or week.

In addition to the weighing unit, a Richardson System includes gates and spouts for conveying coal from the overhead bunkers to stokers or pulverizers. The MONORATE Non-Segregating Spreader assures even distribution across the stoker hopper without segregation of coarse or fine coal.

Bulletin 1143 may prove that the Richardson System can save you coal—the largest single item in cost of steam production. Write today for a copy.

348

RICHARDSON SCALE CO.

CLIFTON, N. J.

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Minneapolis • Detroit • San Francisco • Toronto • Wichita • Pittsburgh

ticularly at high frequencies. Deflection plate leads are brought out through the glass envelope wall, minimizing shunt-input deflection-plate capacitance and lead inductance, and also preventing interaction between signals caused by coupling between long leads. Second-anode leads are also brought out through the envelope wall in order to provide better insulation and longer leakage paths. A standard Army-Navy diheptal 12-pin base fits the standard socket. The electrode voltage ratings are similar to those of the Army-Navy preferred Type 5CP1. Contact connectors for electrode leads are supplied with the tube.

Safety Vents with Rupture Diaphragm

J. A. ZURN MFG. CO., Erie, Pa., has developed a type of safety vent that contains a special disc or rupture diaphragm that will break to relieve excessive pressures which build up within a storage tank. Thus, by permitting the escape of unusually high pressure, danger from explosions is reduced to a minimum.

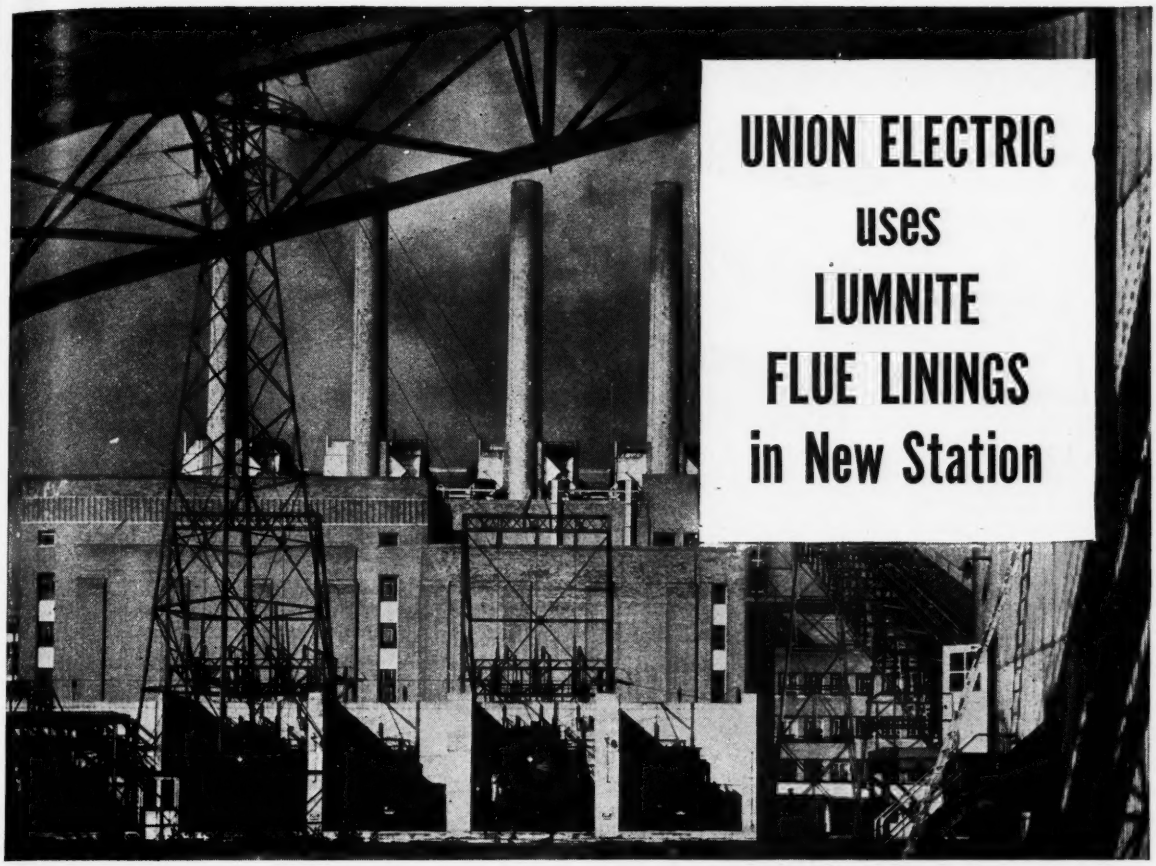
In addition to the rupture diaphragm, these units have the ordinary function of permitting a safe escape of inflammable gases from a tank. This is accomplished by means of a specially designed unit with perforated brass flame barrier plates. Exhaustive tests have proven that this feature prevents flames from flashing back through the perforated vent plates into the tank where inflammable liquids might be ignited.

Safety vents are made in cast bronze, steel, semi-steel or cast iron, with flange or butt-weld connections, in a wide range of sizes.

NEWS *from* THE FIELD

Boilers Shipped Overseas in Four Packages

COMPONENT PARTS of a 54-ton boiler plant in four packages allowing a maximum amount of pre-field construction and insuring against corrosion or damage in the shipment



Union Electric Company's Venice No. 2 Station, near St. Louis
Stone & Webster Engrg. Corp., Boston, Engineers and Constructors
Gunite Concrete Construction Co., St. Louis, Cement-Gun Work
Wiederholt Construction Co., St. Louis, Chimneys

Lasting Protection for Uptake Flues and Fly-ash Precipitators

Burning 2880 tons daily of Illinois coal sets up serious abrasion and corrosion threats from ash and sulphur. In its new 160,000-kw station at Venice, Illinois, the Union Electric Company serving Greater St. Louis protected its uptake breechings and fly-ash precipitators against these hazards by installing LUMNITE linings.

The protective linings, of concrete made with LUMNITE cement and Haydite aggregate, were "shot" on by cement gun over reinforcing wire mesh previously attached to the steel. This method of application provided a solid, unbroken protective layer that covered seams, rivets, bends and corners, and hard-to-get-at places as well as the more accessible flat surfaces. Intimate contact between the LUMNITE concrete and the steel shell prevents moisture and gas from attacking the steel. The thin layer of LUMNITE concrete—two inches—also gives adequate insulation with minimum reduction of draft area.

In the chimneys, 125 feet high (above roof), LUMNITE mortar was used for laying the brick linings—assuring protection against attack by sulphurous fumes and moisture. Some intermittent operation of the plant is anticipated, with the resulting low-temperature periods that permit formation of corrosive condensate within the stacks. Union Electric had previously used LUMNITE mortar in chimney linings in their Cahokia and Ashley Street Stations and found it an effective method of controlling corrosion.

Many power plants use LUMNITE for a variety of purposes, such as:

* **Ash Pit and Cinder Catcher Linings**
* **Coal Bunker Linings**
* **Flue and Duct Linings**
* **Linings for Steel Stacks**
* **Mortar for Brick Chimneys and Linings**
* **Castable Refractories**
* **Overnight Structural Concrete**

Write for further information on the use of LUMNITE in power plants.

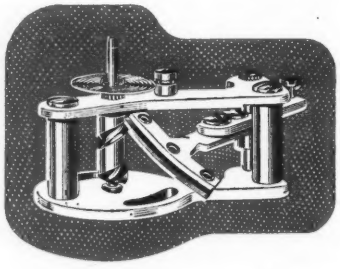
THE ATLAS LUMNITE CEMENT COMPANY

(United States Steel Corporation Subsidiary)

135 East 42nd Street • New York 17, N.Y.

AMERICAN CHAIN & CABLE CO., INC. has acquired the business of the Certified Gauge & Instrument Corp.

The Certified pressure gage, which has proved to be so revolutionary because of the Helicoid movement, will hereafter be manufactured by American Chain & Cable. For the sake of clarity, this precision instrument will be known as the Helicoid Gage.



The Helicoid movement is used exclusively in Helicoid Gages

The outstanding performance of the Helicoid Gage will be even further improved by the engineering ability and experience of American Chain & Cable.

If you are not now using Helicoid Gages and if you desire to reduce your gage maintenance cost, order them the next time.

See your nearest Distributor.

ACCO

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HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

In Business for Your Safety

11-CG-2

have recently been sent overseas from the branch assembly plant at Kent, Ohio, of The Babcock and Wilcox Co.

These package unit boilers are designed to produce 12,000 lb of steam per hour and are about the size used to supply steam for a small laundry. They are ear-marked for export to Russia and China where they are expected to play an important part in postwar reconstruction. Serving in bombed or isolated areas, they will provide the nucleus around which a more extensive power system may be built.

Each plant has a capacity of 500 kw with operating pressure of 300 psi and a superheater temperature of 700 F. Designed to burn wood, peat or low grade coal, one package unit includes boiler, superheater, and economizer, and is equipped with stoker, stack, induced and forced draft fans, soot blower apparatus, automatic damper control, feedwater regulator and other standard boiler equipment.

Since the summer, when U. S. Army officials, Russian representatives and engineers from the firm of Peter F. Loftus, Pittsburgh, Pa. consultants on the project, first witnessed the successful test run of a unit here, workmen have been busy putting together one after another of the compact power plants for shipment to America's allies overseas. Thirty-one units are being supplied by Babcock and Wilcox, 19 of them destined for Russia and the remainder for China. The boilers are built at the company's main plant in Barberton, O.

Packed to Save Ship Space

"Packaging" the units, so that they will meet rigid government shipping requirements is the main job of the assembly plant here. Not only must the shipping space occupied by the units be cut down to an absolute minimum, and meticulous care be taken to guard against corrosion and weight shifting, but there must be a maximum pre-shipping assembly of the parts. This is necessary in order to make erection in the field, where skilled labor is often unavailable, as simple as possible.

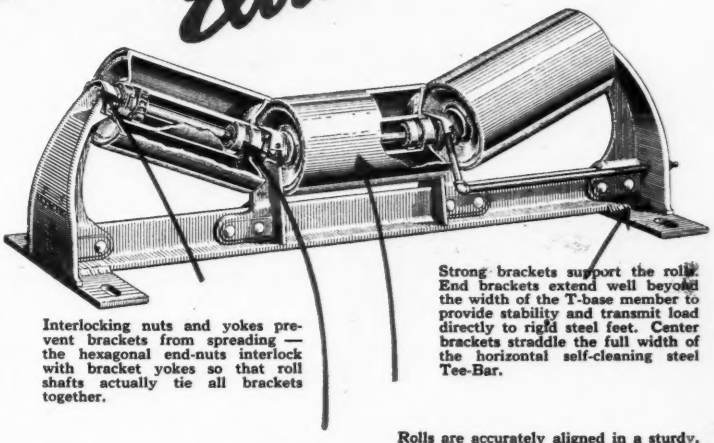
For example, such equipment as the forced draft fan, the gas outlet and damper, and certain piping are partially assembled before packaging. The forced draft fan goes into the shipping crate with the motor attached, ready to be put into place when it reaches its destination. The gas outlet, damper and expansion joint are shipped as one piece; all boiler and soot blower piping is cut, bent, and threaded and assembled into units readily attached to the boiler in the field.

Protected from Corrosion

Corrosion is one of the major hazards of shipping. Since all the equipment is guaranteed for 18 months, the most minute precautions are taken to prevent its occurrence. All highly machined metal surfaces, or any metal operational mechanism such as ball bearings, water column internals, motor and fan shafts, gas outlet regulator, etc. are first processed with a sticky, black corrosion-resistant material known as gohene oil, and then wrapped in heavy self sealing paper. This latter is dipped into a molten paraffin solution, dried, and wrapped

IT'S THE ENGINEERING OF EACH PART THAT GIVES YOU THAT

"Extra" in Service



Interlocking nuts and yokes prevent brackets from spreading — the hexagonal end-nuts interlock with bracket yokes so that roll shafts actually tie all brackets together.

Strong brackets support the roll. End brackets extend well beyond the width of the T-base member to provide stability and transmit load directly to rigid steel feet. Center brackets straddle the full width of the horizontal self-cleaning steel Tee-Bar.

Rolls are accurately aligned in a sturdy, streamlined frame assembled in jigs to assure correct bracket spacing and roll interchangeability.

POSITIVE GREASE SEAL keeps grease in and dirt out—conserves lubrication — prolongs bearing life. No springs, no loose parts, no sliding metal-to-metal contact.

● Top performance in belt conveyors depends, in great measure, on the structure on which the load moves. LINK-BELT Roller Bearing Belt Conveyor Idlers are the outgrowth of almost 50 years of constant development. Engineering that progressed to keep ahead of growing service needs has achieved outstanding design in today's LINK-BELT IDLERS.

You can depend on them, and there is every reason why, to require minimum power and maintenance — to perform smoothly and dependably and to add to the ordinary life of belts.

●

Book No. 1915 gives full particulars

This 16-page book is packed with detailed information on LINK-BELT Belt Conveyor Idlers and the various types available in the "100" series. Drawings are shown with tables giving list prices, dimensions in inches, and weights in pounds. Write today for this book.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Toronto 8, Pittsburgh 19, Cleveland 13, Detroit 4, New York 7

9961

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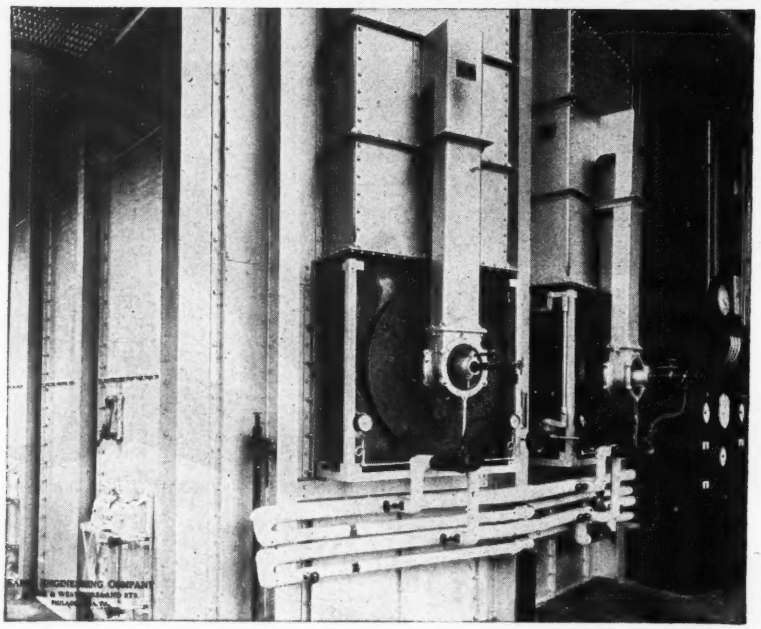
BELT CONVEYOR EQUIPMENT

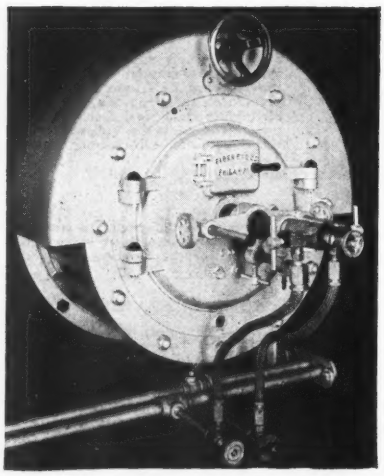
IDLERS • TRIPPERS • BELTS • PULLEYS • BEARINGS • DRIVES

FABER OIL BURNERS



FABER OIL BURNERS Shown Above Used in Combination with Pulverized Coal Burners in An Eastern Paper Mill

Faber have been Manufacturing Engineers since 1923 of Mechanical-Steam-Air atomizing oil burners . . . Various types of gas burners . . . Burners adaptable to all types of Pulverized Coal Burners. Fuel Oil Pump and Heating Units.



Type "B" Steam Atomizing Unit

FABER BURNERS

adaptable to manual or automatic control. Wide range capacity of 5 to 1000 gallons per hour covering steam plants, refineries and industrial processes. Designed for any grade of Light and Heavy Fuel, Tar or Acid sludge, or in combination with Gas or Pulverized Coal.

If you are faced with fuel changes or the need of boosting the efficiency and outputs of your boilers, find out how easily Faber Burners can be installed and operated.

Send for Descriptive Catalog No. 45

FABER ENGINEERING COMPANY

PHILADELPHIA 34, PA.

in a special waterproof paper. This four-times protected package is finally crated in a wooden shipping case, which in turn is placed in one of the four main "packages" of the unit. The big wooden shipping crates, into which smaller equipment is packed, are lined with wood board and asphalt placed between two layers of tar lining paper—all part of the battle against moisture.

Other parts of the boiler receive different treatment in the fight against corrosion. Tubes and stoker grates are sprayed with a special oil and painted before crating. A tray containing a silica gel is placed inside each drum to absorb moisture. Threaded pipe and fittings are all coated with the thick anti-corrosion material and then wrapped in burlap. All welded surfaces receive a coat of red lead in addition to painting.

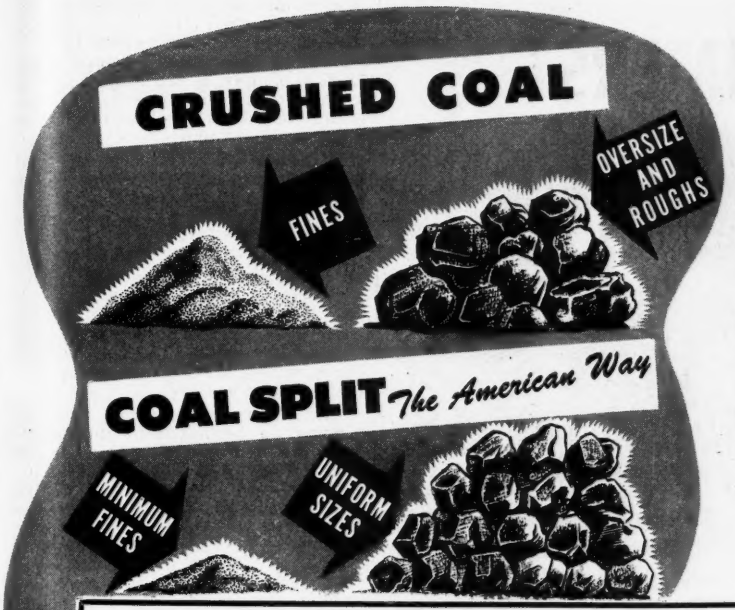
All equipment must meet strict government regulations regarding the arrival of material at its destination in first class condition. Shifting of the parts en route might result in breakage or damage which would in turn cause added expense and trouble at the other end. To guard against such contingencies, the boiler unit, for example, is fitted into what are known as "skid-side" frames. This is a steel structure which ties the boiler, superheater and economizer rigidly together, so that it can be moved easily and without shifting from place to place. Smaller parts are wrapped individually and packed with the same care that is given to wrapping chinaware in a department store. Bricks are packed tight together like dishes, with cardboard and paper between them to prevent friction during transit; wood-burning grates are stuffed into boxes similar to the bricks, but each one is tied in place with wooden sticks between to prevent jarring. Before shipping each piece is tied down and blocked in position.

The four "packages" into which the equipment for each unit is placed, are shipped on two railroad cars. Two of the packages are wooden crates about 7 ft by 7 ft by 17 ft, weighing 9 and 14 tons each. These contain such auxiliary equipment as stoker parts, the induced and forced draft fans and piping. A third package consists of the stack, which is 25 ft in length and weighs one and a half tons. The fourth package is the boiler unit itself, consisting of the superheater, economizer and furnace. The size of the packages has been so designed that they can be handled on continental railroad cars, where clearance is lower than in the United States.

Every item is marked with an identification tag, and three copies of the export packing list, itemizing every piece of equipment, are dispatched with each crate, one on the inside and two on the outside of each major shipping unit. A book of instructions, including blue prints and construction information goes along too in a small wooden box, having first been wrapped in self sealing paper, dipped in paraffin and placed in a waterproof wrapper.

Soft Coal Stock

SOLID FUELS ADMINISTRATION for War has estimated that soft coal stocks in consumers' hands on September 1 totaled 51,141,000 tons, 12,-



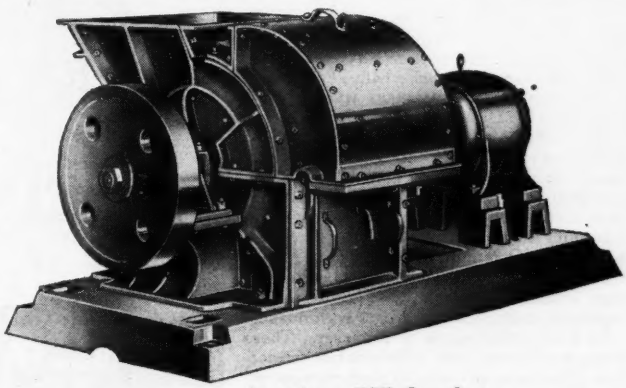
HOW UNIFORM COAL REDUCTION INCREASES COMBUSTION EFFICIENCY

with American Rolling Ring Crushers . . . .

American's Shredder Ring action of SPLITTING coal for uniform sizing reduces combustion losses by excess air and ashpit drop

Stoking with coal uniformly sized by American Crushers *increases firing efficiency from 2½ to 8%*—as shown by a series of actual 24 hour operating tests (by an impartial agency) as recorded with CO_2 charts—in comparison with other types of convential crushers.

The *quality of the crushing* is actually more important than the quality of the coal to efficiency of combustion. Improperly crushed high grade coal can deliver less BTU's per pound than properly crushed coal of uniform size.



American "S" Crusher

American "S" Crushers especially designed for power plants are built in 9 different sizes—in capacities from 25 to 500 TPH.

The operating cost of American Crushers is less than 1c per ton. Their dynamically balanced rotor construction and *double use* of centrifugal force—rather than high speed—minimizes power demand.

Ask any of the many who operate Americans—all over the world!

AMERICAN'S SHREDDER RINGS

A patented feature exclusive with American Rolling Ring Crushers—Manganese Steel Shredder Rings with 20 cutting edges. Revolving free at terrific centrifugal force, they deflect unharmed in contact with tramp metal. No shear pins or conventional safety devices that require attention.

Send for Informational Bulletin of coal crushing data and specifications

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1429 Macklind Avenue
St. Louis 10, Mo.

3 "OLD TIMERS"

5. Inglis Leslie, President, and R. J. (Bob) McIlwain, oldest employee and foundry consultant, inspect 35-year old veteran LESLIE Reducing Valve.

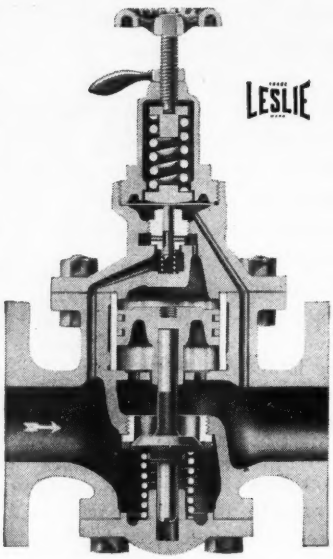
The above illustration marks three separate yet closely related records of service, each indicative of long-term LESLIE quality and reliability.

For, the recent arrival of a 10 in. LESLIE Class F Reducing Valve back for its first repairs after 35 years of hard service, likewise marked 40 years of service with LESLIE CO. of two men closely identified with long-life records of LESLIE Products.

This Reducing Valve, used for controlling steam to reciprocating engines, needed only minor repairs. Following that, it was again returned to the same service, after receiving (and successfully standing) the same rigid maximum steam pressure and operating tests which it underwent prior to shipment 35 years ago—ample indication of a quality that has kept abreast of the best in materials for regulator manufacturing and performance.

To borrow the words of one user, "These Reducing Valves give unbelievable satisfaction. Their constant reliable performance will please any engineer. They are as reliable as the setting sun."

SEND FOR your copy of Bulletin 401-A giving latest engineering data on Pressure Reducing Valves for steam and air service.



Class L-3 LESLIE Pressure Reducing Valve, Self-contained, Spring loaded, internal pilot, piston operated.

LESLIE CO.
257 Grant Avenue • Lyndhurst, N. J.

LESLIE factory-trained engineers to help you with your regulation problems are located in these cities:

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ESTABLISHED 1900
LESLIE CO.

PRESSURE REDUCING VALVES · PUMP GOVERNORS · PRESSURE CONTROLLERS
TEMPERATURE REGULATORS · SELF CLEANING STRAINERS · LESLIE-TYFON WHISTLES

768,000 tons less than those of a year ago. The monthly stock report showed that the coal held in storage by consumers on that date averaged about 38 days 'supply, at the August rate of consumption. This was an increase of only one day's supply over the coal in storage on August 1.

In view of the widespread soft coal strike, there is little hope that stocks can be further increased against this winter's requirements, Administrator Ickes said.

All consumers are urged to conserve their fuel rigidly, because the Appalachian-mined coal now available for distribution must be held for emergencies and for such consumers as hospitals, public utilities, and railroads, whose services are indispensable to public welfare.

The effects of the strike were beginning to be apparent during the week ending September 29, when soft coal production was estimated at 10,930,000 tons, a decrease of 670,000 tons below that of the preceding week. It was some 1,250,000 tons less than the comparable week of 1944.

As of September 29, soft coal production for the calendar year totaled about 437,838,000 tons, a decrease of 7.2 per cent below 1944 output.

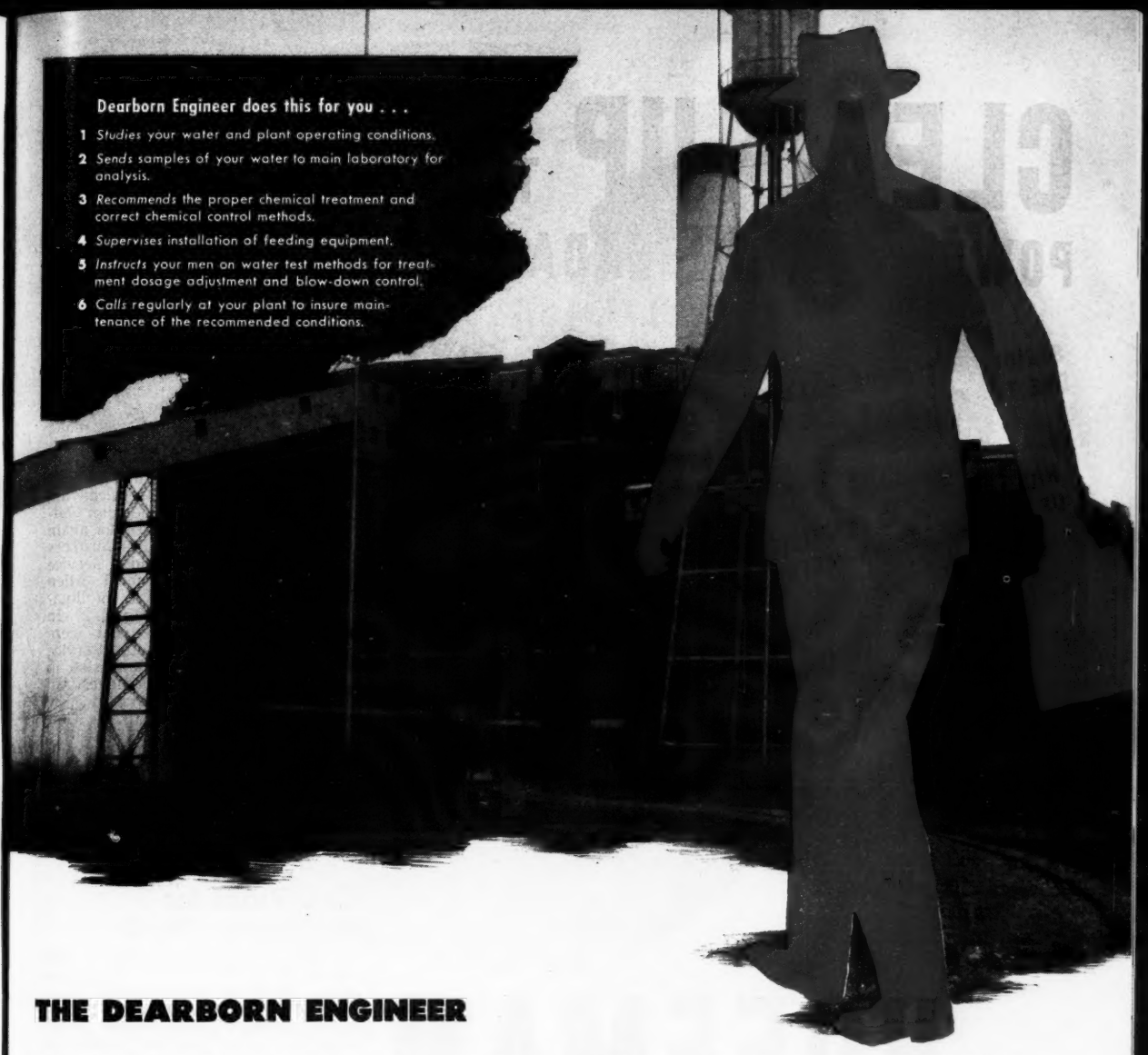
D. Robert Yarnall Elected President of ASME

D. ROBERT YARNALL, co-founder and president of the Yarnall-Waring Co. of Philadelphia and a director and president of the James G. Biddle Co. of that city, has been elected president of the A.S.M.E. for 1945-46. The election was the result of national balloting by the membership by letter, just tabulated. Mr. Yarnall will assume office at the conclusion of the 66th Annual Meeting, November 26-30, in New York. He will succeed Alex D. Bailey of Chicago.

Also elected by letter vote were the following: For regional vice-presidents to serve two years: Alexander R. Stevenson, Jr., staff assistant to the vice-president of engineering, General Electric Co., Schenectady, N. Y., Samuel R. Beitler, associate professor of hydraulic engineering, Ohio State University, Columbus, Ohio, and J. Calvin Brown, head of the firm of J. Calvin Brown, Los Angeles; regional vice-presidents to serve one year: Rudolph F. Gagg, assistant to the general manager, Wright Aeronautical Corp., Paterson, N. J., Edward E. Williams, general superintendent of steam plants, Duke Power Co., Charlotte, N. C., and Linn Helander, head of the department of mechanical engineering, Kansas State College, Manhattan, Kans.

Elected directors - at - large were Edgar J. Kates, consulting engineer, New York, and J. Noble Landis, assistant mechanical engineer, Consolidated Edison Co. of N. Y. Nominations were announced following a meeting of the Nominating Committee in Chicago in June.

Mr. Yarnall has been for more than a quarter of a century actively engaged in the engineering field. He has served abroad in relief work in two wars. He has been a member of


Dearborn Engineer does this for you . . .
1 Studies your water and plant operating conditions.
2 Sends samples of your water to main laboratory for analysis.
3 Recommends the proper chemical treatment and correct chemical control methods.
4 Supervises installation of feeding equipment.
5 Instructs your men on water test methods for treatment dosage adjustment and blow-down control.
6 Calls regularly at your plant to insure maintenance of the recommended conditions.

THE DEARBORN ENGINEER

SERVES THE POWER INDUSTRY

The Dearborn Engineer is within calling distance of your plant. When trouble starts in the boiler room, he can be on his way pronto to head it off. He knows local water characteristics and comes fully equipped to make on-the-spot analyses of water samples and plant operating conditions.

Long experience as a water expert enables him to work with your men in installing initial corrective measures to prevent boiler shutdowns due to scale, foaming, and corrosion. His findings are then double-checked by Dearborn home laboratories and there chemical formulas and control methods are established to fit your individual needs and end your boiler water troubles for all time.

Get in touch with the Dearborn Engineer in your district or write to us direct. We'll see that he calls promptly.

DEARBORN CHEMICAL COMPANY, Dept. F, 310 S. Michigan Ave., Chicago 4, Illinois.

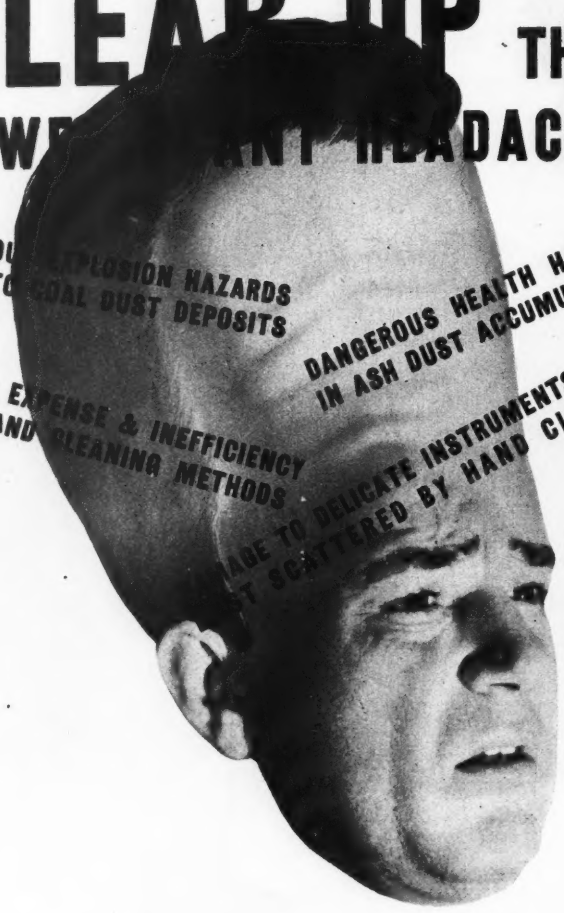
Dearborn

TRADE MARK REGISTERED

THE *LEADER* FOR OVER 25 YEARS

ENGINEERING SERVICE AND WATER TREATMENT

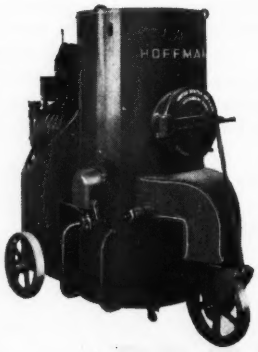
CLEAR UP THESE POWER PLANT HEADACHES


DANGEROUS HEALTH HAZARDS IN ASH DUST ACCUMULATIONS
DAMAGE TO DELICATE INSTRUMENTS FROM DUST SCATTERED BY HAND CLEANING

WITH HOFFMAN

PORTABLE OR STATIONARY VACUUM CLEANING EQUIPMENT

Call Hoffman for the economical remedy for power plant headaches due to dust. A Hoffman stationary vacuum cleaning system – or heavy duty portable cleaner – accomplishes a more thorough cleaning job with less work, improves plant conditions and eliminates hazards due to dust. Hoffman has specialized for many years in power plant cleaning problems; Hoffman equipment is standard in many large power companies.



➡ **SEND FOR LITERATURE**

U.S. HOFFMAN MACHINERY CORPORATION
AIR APPLIANCE DIVISION, 101 FOURTH AVE., NEW YORK 3, N. Y.

the City Planning Commission of Philadelphia since 1942, having been reappointed in 1944 for a five-year term.

Mr. Yarnall is a native Pennsylvanian of Quaker ancestry. He was born in Delaware County, and received the degree of B.S. from the University of Pennsylvania in 1901. He received the degree of mechanical engineer in 1905.

In 1908 with B. G. Waring, he organized the firm of Yarnall-Waring Co. and has been continuously identified with it since that time. The company manufactures power plant specialties.

Mr. Yarnall was awarded the Hoover Medal by the A.S.M.E. in 1941. In the following year he was made Doctor of Engineering by Lehigh University.

He served as a member and as head of the commission in Europe having charge of the feeding of German children in 1920. In 1924 he was again sent to Germany under the auspices of the American Friends Service Committee and the General Allen Committee having charge of the liquidation of the relief program. In June, 1938, he and Mrs. Yarnall were sent by American Friends Service Committee to Austria to assist in organization of relief of refugees. In 1938 and 1939 for this Committee, he was in Berlin to protest to the German Government against atrocities. In 1941 he was a member of the commission to England to make a survey of relief needs due to war, and to consult the British Government about shipment of more food through the blockade for the aid of children and mothers of France.

New Plant for Mathieson Alkali

A NEW PLANT which will double the output of sodium chlorite is now being added to the Niagara Falls, New York, production facilities of The Mathieson Alkali Works. Construction cost of the new building is estimated at $35,000 and its total cost at about $323,000.

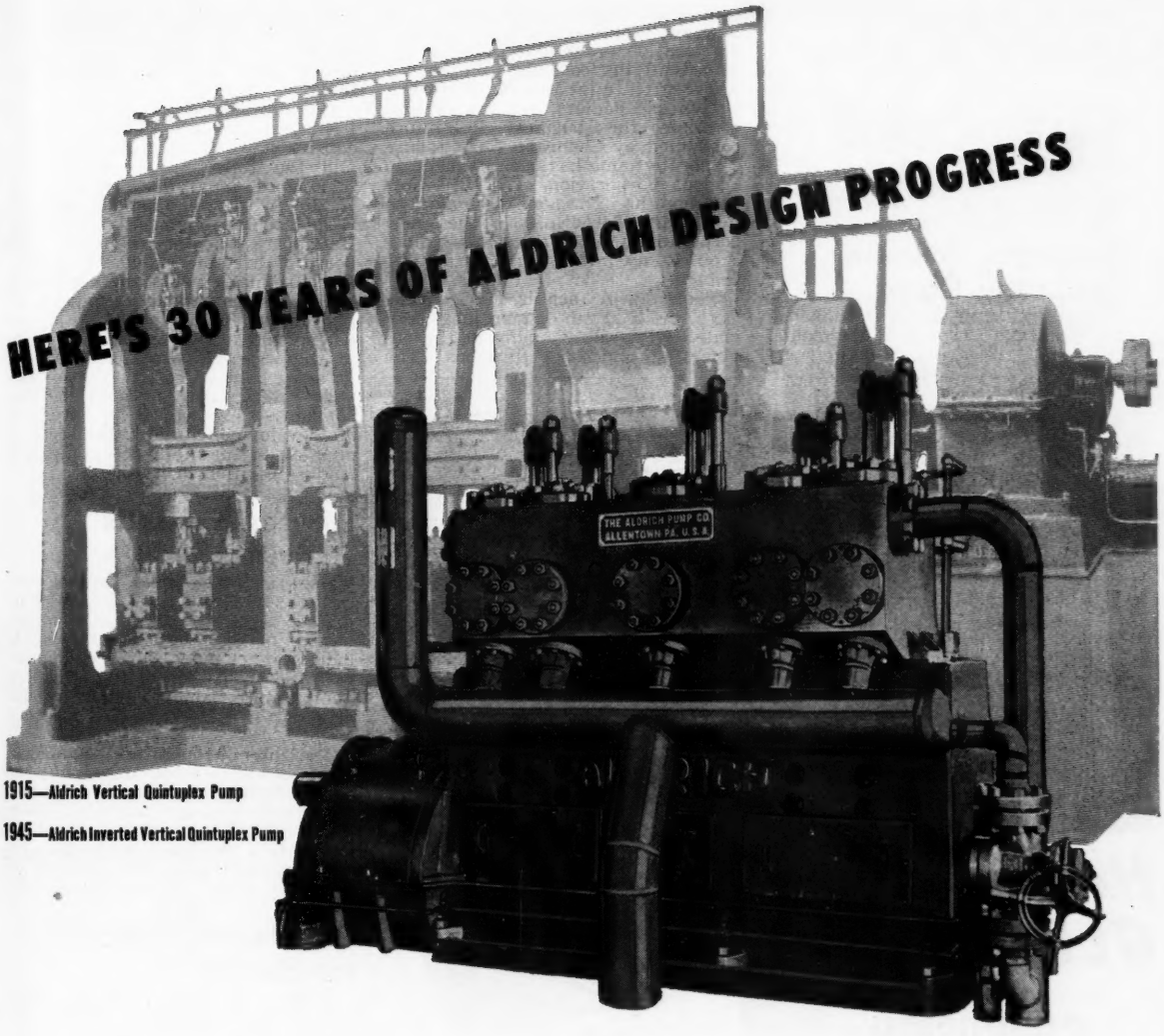
Sodium chlorite was made commercially available by Mathieson in 1940. Since then, its major uses have been as a bleach and oxidant in the textile and paper pulp industries. During the past year, it has come into use for the removal of tastes and odors in a new process for treating public water supplies, but only a few cities have been able to take advantage of this development, because of the inadequate supply of the chemical.

Annual Meeting of the ASRE

THE 41ST ANNUAL MEETING of The American Society of Refrigerating Engineers is scheduled for Monday, Tuesday and Wednesday, December 10 through 12, 1945, at the Hotel Pennsylvania, New York City.

Four technical sessions have been planned by Charles S. Leopold, national vice president and chairman of the program committee. Special entertainment features are in the hands of the New York Section of the Society, under the leadership of Chairman Paul B. Christensen. Many of

HERE'S 30 YEARS OF ALDRICH DESIGN PROGRESS



1915—Aldrich Vertical Quintuplex Pump

1945—Aldrich Inverted Vertical Quintuplex Pump

• When placed in operation thirty years ago, the Aldrich Vertical Quintuplex Pump was the best that money could buy. Weighing 90,000 pounds and covering 145 square feet of floor space it was an engineering achievement built to operate under severe conditions for many years. With only routine maintenance and repairs, this pump *is still in operation.* Little wonder that Aldrich pumps have a reputation for sound design and construction.

Today, Aldrich Inverted Vertical Quintuplex Pumps are being specified for similar service. Through Aldrich modern design, a pump of comparable capacity would show that weight is reduced almost 73% to 25,000 pounds and floor space is reduced almost 83% to 25 square feet. These advantages reduce initial costs and operating expenses without sacrificing rugged, long-life construction.

Why not call on Aldrich engineers for assistance in the solution of your pumping problems? They have been doing this work for more than 40 years, and their specialized experience is available to you. Write to The Aldrich Pump Company, Allentown, Pa.

Representatives: Akron • Birmingham • Bolivar, N. Y. • Boston • Chicago • Cincinnati • Cleveland Denver • Detroit • Duluth • Houston • Jacksonville • Los Angeles • New York • Omaha Pittsburgh • Portland, Ore. • St. Louis • San Francisco • Seattle • Tulsa

ALDRICH . . . anticipates industry's pumping needs

the Society's technical and other committees are scheduling meetings of their members during the three-day period.

MANUFACTURERS' *News*

Employes Acquire Cochrane Corp.

ANNOUNCEMENT HAS been made by the Cochrane Corp. of Philadelphia, Pa., that all of its operating assets have been transferred to a new corporation known as HSB Corporation, which corporation assumed all the contracts and obligations with customers, suppliers, agents and dealers, and proposes to continue the business heretofore conducted by Cochrane Corp. whose corporate name has been changed to Raneco Corporation. The HSB Corporation has changed its name to Cochrane Corporation. The new corporation was not affected nor did it acquire any interest in Rotameters, Inc.

Those who acquired Cochrane Corp. are a group of men long associated with the company in the engineering and sales divisions. The new corporation will be managed and operated by its owners, and will continue the manufacture of steam power plant and industrial equipment.

Officers elected to carry on the business of the new Cochrane Corp., consist of T. E. McBride, president; and the following vice-presidents: C. E. Joos, apparatus division, V. A. Rohlin, works manager, A. E. Kittredge, chief engineer, and E. S. Daugherty, heater division. The board of directors includes H. E. Sibson, for many years the company's general sales manager and W. V. Sauter of Philadelphia. It is reported that no changes will be made in the widely-known Cochrane line or sales policies, nor in the nationwide sales representation of the company. An aggressive program of development and research is planned to maintain the company's leading position in its field.

Bowser Expands Activities

BOWSER, INC., liquid control specialists of Chicago, Ill., and Fort Wayne, Ind., became the country's largest manufacturer specializing in industrial temperature equipment with the acquisition of the Industrial Temperature Cabinet equipment business of the Kold-Hold Co., Lansing, Mich.

The low temperature equipment business will be consolidated with the Refrigeration Division of Bowser, which is located in Long Island, New York. This entire division will be moved to a new home in the near future and these units will be called by the trade name "Bowser-Kold-Hold."

Charleston Office for Hewitt

A NEW CHARLESTON, W. VA., office has just been opened by Hewitt Rubber Corp. and its subsidiary, Robins Conveyors, Inc., to offer more complete engineering service to coal mines and other industries in the Southeastern states, according to recent announcement by president Thomas Robins, Jr.

Established for more than 85 years, Hewitt is a leading producer of rubber conveyor belts and all types of industrial hose in its plants at Buffalo, N. Y. In Passaic, N. J., Robins manufactures all types of conveying systems and the company is known as the designer of many mine conveyors used throughout the Southern coal fields.

Dover Industries, Inc., Now in Operation

DOVER INDUSTRIES, INC., announces the start of operations at its plant located at 2929 N. Campbell Ave., Chicago 18, Ill. This is a new enterprise which was organized to do manufacturing and jobbing of metal articles requiring plated finishes. The company's executives have each had from ten to twenty years of experience in the metal finishing industry. L. D. Jensen, formerly vice president of Chromium Corp. of America, is president; O. A. Wettlaufer, and E. L.

COCHRANE Deaeration SAVES!

Deaeration of boiler feedwater is one of the big items of economy in power plant operation.

Cochrane Deaerators of varying sizes, designs and construction have been protecting the boiler plants of industry for many years. The feed piping, economizers, water walls and tubes of these boilers are effectively protected by Cochrane Deaeration, which removes both dissolved oxygen and soluble gases, and at the same time produces savings in heat and fuel by heating the water to the boiling point.

COCHRANE CORPORATION 3123 **N. 17th ST., PHILADELPHIA 32, PA.**

COCHRANE

SOFTENERS • DEAERATING SOFTENERS • DEAERATORS • METERS • STEAM SPECIALTIES

Berkenkotter, formerly sales manager and plant superintendent, respectively, of Chromium Corp. of America, are vice presidents; and K. W. Schwartz, formerly vice president of United Chromium, Inc., is treasurer.

An industrial site with 45,000 sq ft of available space has been acquired. Modern and complete facilities have been installed for hard chromium plating and heavy nickel plating on equipment weighing up to 5 tons and 22 ft in length. The extensive experience of the organization's engineering personnel is available to the Diesel engine manufacturers in connection with the plating of such equipment as engine liners, crankshafts, wrist pins and many of the other standard applications.

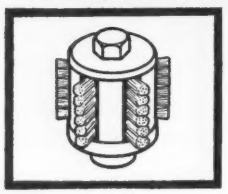
American Chain & Cable Co., Inc., Bridgeport, Conn., has acquired the business of the Certified Gauge and Instrument Corp., of Long Island City, New York. The principal product of the latter company is a pressure gage with a new patented mechanism called the Helicoid movement. Manufacturing will continue at the Long Island City plant under the name Helicoid Gage Division, American Chain & Cable Company, Inc. The acquisition of this new line will supplement the Company's products for markets it now serves.

Robins Conveyors Inc. and its affiliate, Hewitt Rubber Corp., have opened a new office in the United Carbon Building in Charleston, W. Va. R. U. Jackson, who has represented Robins Conveyors in the territory for 15 years, will be in charge of the office, assisted by H. N. Kepler, sales engineer formerly in the Robins Washington office. Handling Hewitt sales will be Nelson J. Reinhold, who has recently joined the company.

General Electric Co. has appointed four men to head newly organized sections in its Control Division, new name of the company's former Industrial Control Division. William M. Anthony is manager sales of the Industry Control section; Edward S. Bush is appointed manager sales of the Appliance and Aircraft Control section; S. V. W. Dockstader has been named manager sales of the General Purpose Control section, and William J. Stock is in charge of the Marketing and Promotion section.

Square D Co. has taken steps to double the size of the present plant in Milwaukee. The present plant, was built in 1940 and enlarged in 1942. A large tract of ground immediately adjacent already is owned by the Company, so construction can be started as soon as plans are completed and materials and labor are available. When completed, the plant's activities will require a materially larger working force.

Why WILSON TUBE CLEANER BRUSHES last 10 to 20 TIMES LONGER



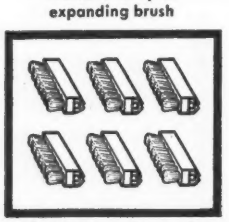
Wilson Expanding Brush

Ten to twenty times as many tubes can be cleaned with a Wilson Expanding Brush than with ordinary sectional brushes before replacement is necessary. When removing the light, powdery deposits or for final polishing of tubes, the savings in time, labor and money derived from this feature alone make the expanding brush an essential part of every tube cleaning equipment.

Frame or body of expanding brush

This longer life results from the expanding action of the brush. Because any brush must be smaller than the I. D. of the deposit it removes, the ordinary sectional brush cleans by vibrating against the inner tube wall with a pounding action which hammers down the brush elements.

In the Wilson Expanding Brush, centrifugal force holds the tufts in constant contact with the deposit — eliminating this destructive pounding. Worn tufts in the Wilson Expanding Brush can be replaced easily and quickly — and at low cost.



Set of refills or faggots for expanding brush

A copy of the Wilson Tube Cleaners Check List will help you select the right Wilson equipment to do your tube cleaning jobs faster and more effectively. Write for your copy today.

Modern tube-cleaners for the problems of today.

wilson PIPE AND TUBE CLEANERS EXCLUSIVELY

TW-696

THOMAS C. WILSON Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

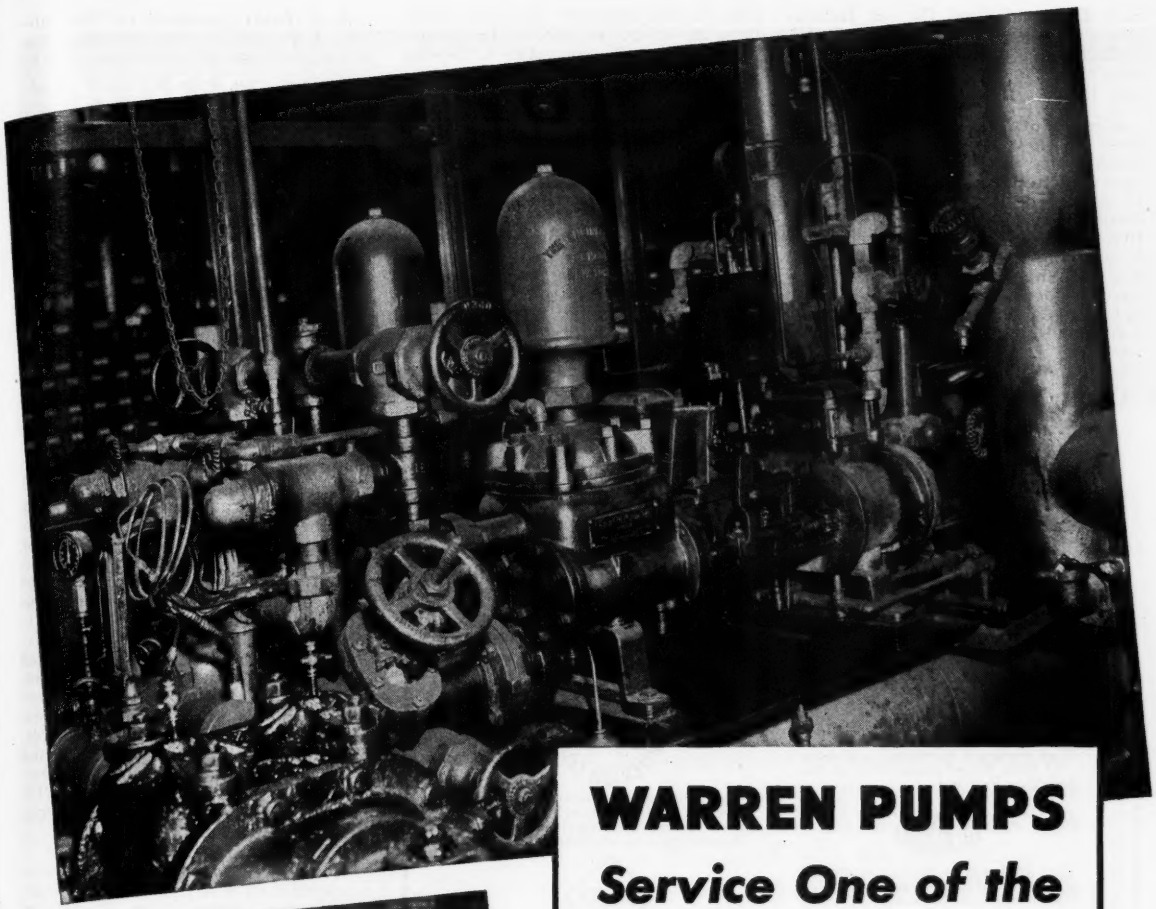
MANUFACTURERS' *Personals*

The V. D. Anderson Co. of Cleveland, Ohio, announces the election of the following officers: Carl W. Zies, president; R. T. Anderson, vice president; A. D. Anderson, treasurer; F. S. Freer, asst. treasurer; B. D. Coffey, secretary and Edward Parsons, asst. secretary. A. D. Anderson is now chairman of the board of directors. Carl W. Zies, newly elected president, has been with the company for 16 years.

E. B. Curdts, who has joined the James G. Biddle Co. organization, until recently was with the Narragansett Electric Co. of Providence, R. I. With a rich background of practical experience in electrical engineering and maintenance, Mr. Curdts will be Biddle's applications engineer. He plans to travel among power companies, railways and large industrial plants to discuss problems of electrical maintenance with particular reference to the use of "Megger" insulation testers, ground testers and low resistance ohmmeters.

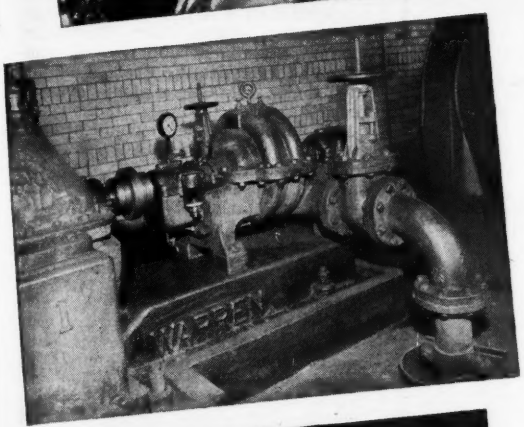
Roberts-Konrad, Inc., 90 West St., New York 6, N. Y., has been appointed as sales engineers and consultants on industrial, public utility and marine water testing problems by TruTest Laboratories, Inc., Philadelphia, Pa. Both principals of this organization, Robert Katz and Robert E. Giauque, have had long experience in marine and industrial power equipment design and service.

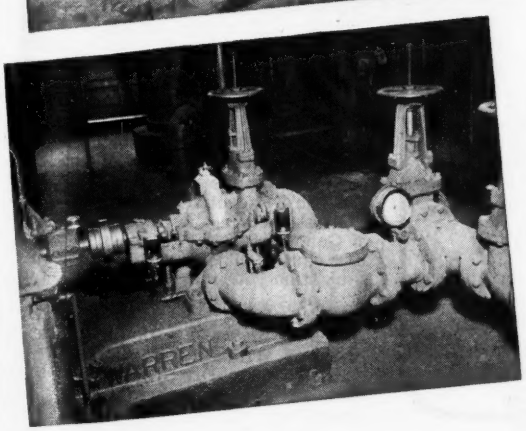
Appointment of Harry C. Ballman as manager of the stoker division of



WARREN PUMPS

Service One of the Country's Largest Gas Plants





Shown here are three of twelve Warren Pumps operating at the gas plant of Public Service Electric & Gas Co., Harrison, N. J.

Top: Horizontal Duplex Fuel Oil Pump (6x4x6), part of the complete pump and heater set furnished by The Engineer Company and which supplies oil for the burners.

Center: A 3-2H-13 pump with a capacity of 250 GPM against a 250' head. Operating 24 hours a day, its function is to maintain a constant water pressure for operating the hydraulically controlled valves in the gas sets.

Bottom: A 4-DS-10 pump with a capacity of 500 GPM against a 55' head, which furnishes the jacket water for all gas compressors.

Write for complete information on this and similar Warren installations.

WARREN STEAM PUMP CO., INC.

WARREN, MASSACHUSETTS

Blue Diamond Coal Co., of Indianapolis, has been announced by R. W. Bidlack, general manager of the company which is one of Indiana's largest coal firms.

Election of Geo. H. Miehls as president of Albert Kahn Associated Architects and Engineers, Inc., to succeed the late Louis Kahn has been announced. The Board of Directors also named Mr. Miehls, formerly executive vice-president, as treasurer of the 40-year old firm. In the same board meeting Sheldon Marston, previously vice-president, was elected to succeed Mr. Miehls as executive vice-president, and two new vice-presidents were named: Saul Saulson and O. L. Canfield. These men, together with Robert E. Linton, vice-president and Geo. K. Scrymgeour, secretary, comprise the executive staff of the organization generally conceded to be the largest in the world in industrial and commercial architecture and engineering.

W. A. Yost, Jr., has been appointed assistant manager of the Allis-Chalmers steam turbine department. Formerly in charge of the department's marine division, Yost, among other duties, will assume direction of sales of steam turbines and the rapidly developing gas turbine. After coming to Allis-Chalmers from the Elliott Co. of Pennsylvania, where he managed that company's steam turbine department, Yost immediately assumed charge of the Allis-Chalmers marine turbine division production.

RODA

High grade gas, by-product and steam coal from Wise County, Va., on the Interstate Railroad.

DENDRON

High grade gas, by-product, steam and domestic coal from Wise County, Va., on the Interstate Railroad.

STONEGA

High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

PREMIX STOKER

A laboratory controlled product blended to meet exacting stoker requirements. From Wise County, Va., on the Interstate Railroad.

COKE

Roda and Stonega from Wise County, Va., and Connellsville Coke from Pennsylvania.

CRITERION COAL

High grade gas, by-product, steam and domestic coal—Pittsburgh seam from Irwin Basin, Westmoreland County, Pennsylvania, on the Penna. Railroad.

CROZER

Genuine Third Vein Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railroad.

Admiralty Coal

Genuine New River Smokeless, Beckley or Sewell seam from Raleigh County, W. Va., C. & O. and Virginian Railroads.

Old Kentucky

Hazard No. 4 and No. 7 steam and domestic coal from Wiscoal, Knott County, Kentucky, on the L. & N. Railroad.

CHARMCO

Unexcelled Steaming Coal from the Fire Creek Seam in Greenbrier County, W. Va., originating on the N. F. & G. R. R.

ANTHRACITE — Hazle Brook Premium . . . Raven Run

General Coal Company

123 SOUTH BROAD STREET, PHILADELPHIA 9, PA.

BRANCHES:

BLUEFIELD, W. VA. BOSTON BUFFALO CHARLOTTE, N. C.
CINCINNATI DETROIT NEW YORK NORFOLK PITTSBURGH

A. G. Pratt, president of The Babcock & Wilcox Co., has announced the retirement from active service of William Sheldrick, who has been an official of the company for 46 years, and the appointment of W. G. Dryden as his successor. Mr. Sheldrick was treasurer and assistant secretary of The Babcock & Wilcox Co. and The Babcock & Wilcox Tube Co.

E. A. Murray has been appointed manager of the manufacturers products department in the Chicago sales office of the American Steel and Wire Co., subsidiary of United States Steel Corp. At the same time, C. J. Quill has been named assistant manager of the department.

Marshall B. Taft, formerly of the Aero Division, Minneapolis-Honeywell Regulator Co., has been made assistant to Henry F. Dever, president of the Brown Instrument Co., Philadelphia industrial division of the Honeywell organization. Mr. Taft was for three years administrative assistant to the vice president of the Aero Division in Chicago. Prior to that time he was practicing law in Minneapolis. He is a graduate of the University of Minnesota.

Appointment of Jack Cole as sales manager of the packing sales department of its industrial sales division, has been announced by Raybestos-Manhattan, Inc., of Manheim, Pa. Mr. Cole rejoins the company after having served with the Government since May, 1942, as deputy director of WPB in the Cork, Asbestos, and Fibrous Glass Division.

Howard F. MacMillin has become associated with Arthur D. Little, Inc., Cambridge, Mass. Mr. MacMillin, formerly president and general manager of the Hydraulic Press Manufacturing Co., Mt. Gilead, Ohio, will direct the application to industry of developments in the mechanical engineering and applied physics fields by the laboratories of Arthur D. Little, Inc. At present this work will concern particularly conversion to peacetime uses of important equipment and processes developed during the war.

Cornell & Underhill, Inc., pipe fabricators of New York and Hoboken, announces the appointment of F. Carroll Stille as sales manager. Mr. Stille has for the past twenty years been associated with the National Tube Co., both in New York and Washington, D. C., in the departments of metallurgy, research, field engineering and sales. He will make his headquarters in the Hoboken Offices of Cornell & Underhill.

George H. Pfeif of Schenectady has been appointed manager of the employee relations section of General Electric's Executive Department. Mr. Pfeif started in the Test department of General Electric in Schenectady in 1905 and in 1908 joined the office organization of the general superintendent of the Schenectady plant. Since then he has been intimately associated in work with such officers as Edwin Wilbur Rice, Jr., Francis C. Pratt, the late Dr. Charles P. Steinmetz, Albert L. Rohrer and E. E. Boyer.

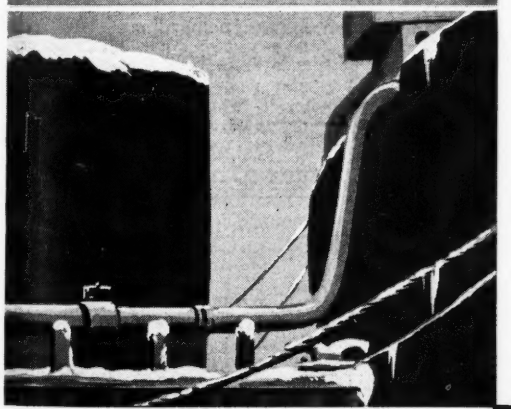
REDUCE *winter* PUMPING COSTS!

use Sier-Bath Screw Pumps

HEATING fluids so that their viscosities will be low enough for your pumps is expensive. In fact, this often costs more than the actual pumping. Reduce this cost by installing Sier-Bath Screw Pumps. They handle high viscosity fluids with low power consumption. And they do not require heavy foundations.

Their pulseless discharge reduces pipe joint strain. In fuel oil service, it prevents "puffy" firing and thus improves boiler efficiency and reduces tip cleaning. High in efficiency, low in maintenance, Sier-Bath Screw Pumps are less affected by head. Even when slanted, they maintain a constant flow. Built to close tolerances, with anti-friction roller bearings as standard design. Removable liners are available. Write for bulletin.

SIER-BATH GEAR COMPANY, INC.,
9256 HUDSON BOULEVARD, NORTH BERGEN, N. J.

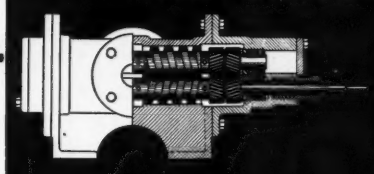


For ACETATES • ASPHALTS • BRINES • BUNKER C FUEL OIL
CELLULOSICS • GREASES • MOLASSES • SYRUPS

Sier-Bath Gear Co. Inc.

Only Two Moving Parts

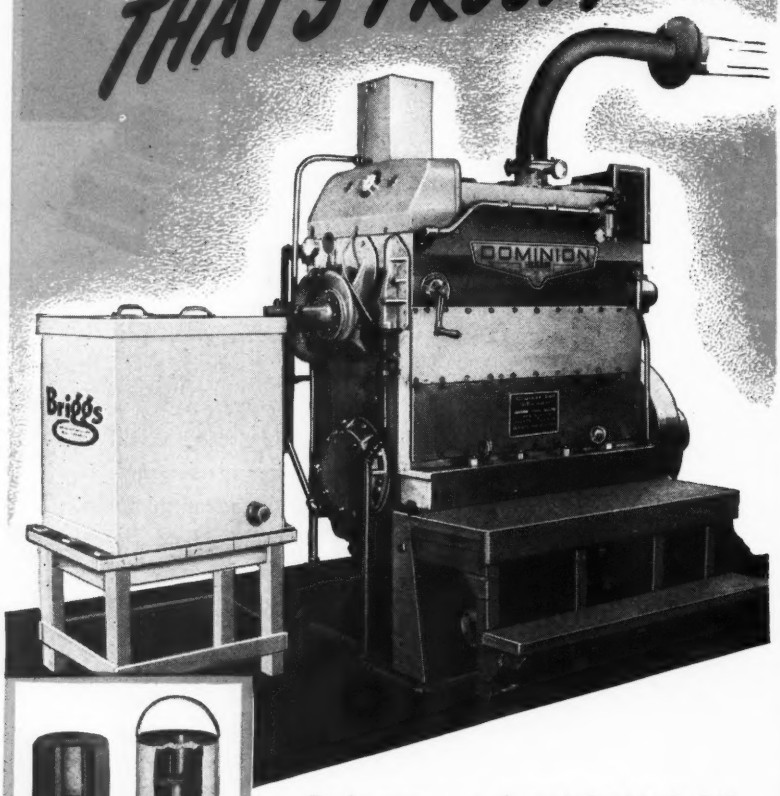
That's why it needs little maintenance.

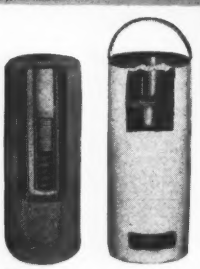


• An occasional repacking is all the attention it needs and that can be done while the pump is running, because there is no pressure on the gland. No thrust bearings needed. No side wear of pumping screws. No valves.

When a manufacturer standardizes on BRIGGS oil clarifiers...

THAT'S PROOF!





LEFT—
For Continuous Maintenance of Straight Mineral Oils— The Briggs Patented Fullers Earth Cartridge that cleans oil 3 times in 3 ways—filters, purifies, clarifies. Exclusive with Briggs . . . nearly 2 decades of outstanding performance backs this principle of oil filtration.

RIGHT—
For Continuous Maintenance of Additive-Type Oils— The Briggs "Discel" (All-cellulose) Type Cartridge, manufactured of specially processed cellulose, provides greater dirt removal because of its unique design. Maximum filtering surface is presented to the oil . . . rated flow is assured at all times.

For five years . . . on the test-bed and in the field . . . Dominion Engineering Company Limited saw how Briggs Clarifiers provided greater operating efficiency and lower maintenance for their Dominion Diesels. As a consequence . . . 60,000 Diesel Horsepower put into industrial service by this Company is now Briggs-equipped.

If your Diesel is not equipped with a Briggs Oil Clarifier you're missing a good bet. Consult the Briggs Distributor nearest you and let him tell you how Briggs Lube and Fuel Oil Clarifiers are able to increase over-all efficiency and why they are a sound investment for you. *There is a Briggs Oil Clarifier for every size and type internal combustion engine . . . for every type oil.*

Briggs

PIONEERS IN MODERN OIL FILTRATION

BRIGGS CLARIFIER COMPANY
***General Offices* — WASHINGTON 7, D. C.**

DISTRIBUTORS IN PRINCIPAL CITIES . . . listed in "FILTERS" section of most classified telephone directories

Henry K. Patjens has been elected president of the Economy Arch Co. of St. Louis. Mr. Patjens was graduated from Clemson College with a degree in mechanical and electrical engineering. He served as an officer in the Navy in World War One. From the Navy he entered the Engineering department of the Baldwin Locomotive Works, where for 17 years he served as a designing and analytical engineer, handling special problems, performance studies, and road testing. In 1937 Mr. Patjens was transferred to the sales department as a sales engineer with headquarters at Chicago. For the past seven years he has served in that same capacity with headquarters in St. Louis.

Walter Dorwin Teague, Industrial Designer, with offices in New York and Los Angeles, announces that he has taken two of his associates into partnership. Robert J. Harper, who joined Mr. Teague's organization in 1935, is Director of Design in the New York office and Mr. C. Stowe Myers, who has been with Mr. Teague since 1934, has the same responsibility in the Los Angeles office.

Rogers Diesel and Aircraft Corp. announces the appointment of Walter Parrish as chief engineer. He will take charge of the engineering, research and development facilities of the parent company, as well as aiding in the formulation of engineering plans for the entire organization which includes the Edwards Co., Sanford, N. C.; Hill Diesel Engine Co., Lansing, Mich.; Ideal Power Lawn Mower Co., Lansing, Mich.

Gunnar Sinding-Larsen who has been with the Pittsburgh Piping & Equipment Co. of Pittsburgh, Pa., for 21 years, during which time he has engineered many unusual installations in the fields of hydraulics, high pressure steam and compressed air, and in the chemical industries, now assumes the new duties and responsibilities of vice president.

D. M. Weir, Jr., who joined the Pittsburgh Piping and Equipment Co. in 1931, after an association of 14 years with the Pittsburgh Valve Foundry and Construction Co., has served as sales engineer for the company for 14 years prior to his recent appointment as general manager of sales.

STATEMENT of the ownership, management, circulation, etc., required by the Acts of Congress of August 24, 1912, and March 3, 1933, of Power Plant Engineering, published monthly at Chicago, Illinois, for October 1, 1945, State of Illinois } ss.
County of Cook }

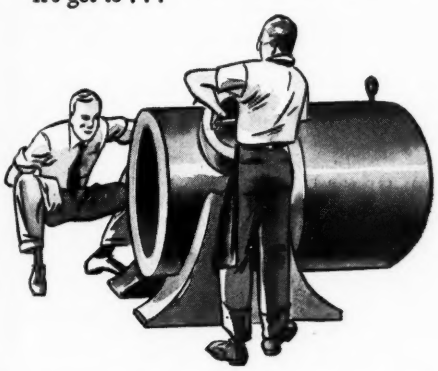
Before me, a Notary Public, in and for the State and county aforesaid, personally appeared Kingsley L. Rice, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Power Plant Engineering and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws

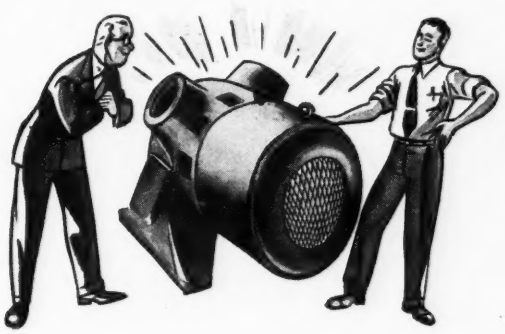
"So They Dumped an 1800 lb. Compressor in Our Lap!"

"It's Yours, Old Man," said the Sullivan Machinery Co. to the Allis-Chalmers engineer. "All that compressor needs to make it happy is a motor. But it's got to have the right qualifications before it can keep company with my machine!"

"I Don't Want This! Looks like the motors in San Francisco and the compressor's in New York. What I want is a motor that'll hug that compressor so close you can't tell where one starts and the other ends. It's got to . . ."

Well, That Compressor Manufacturer made our heads whirl. Lighter . . . more compact . . . simple design . . . rugged construction . . . trouble-free . . . these were only part of what he wanted. So we measured and figured and made designs . . .





We Cut Overall Size by pressing the rotor on the compressor shaft. That eliminated motor bearings and with it lubrication worries and any chance of misalignment. A new type of housing reduced weight, helped pack more hp into less space.

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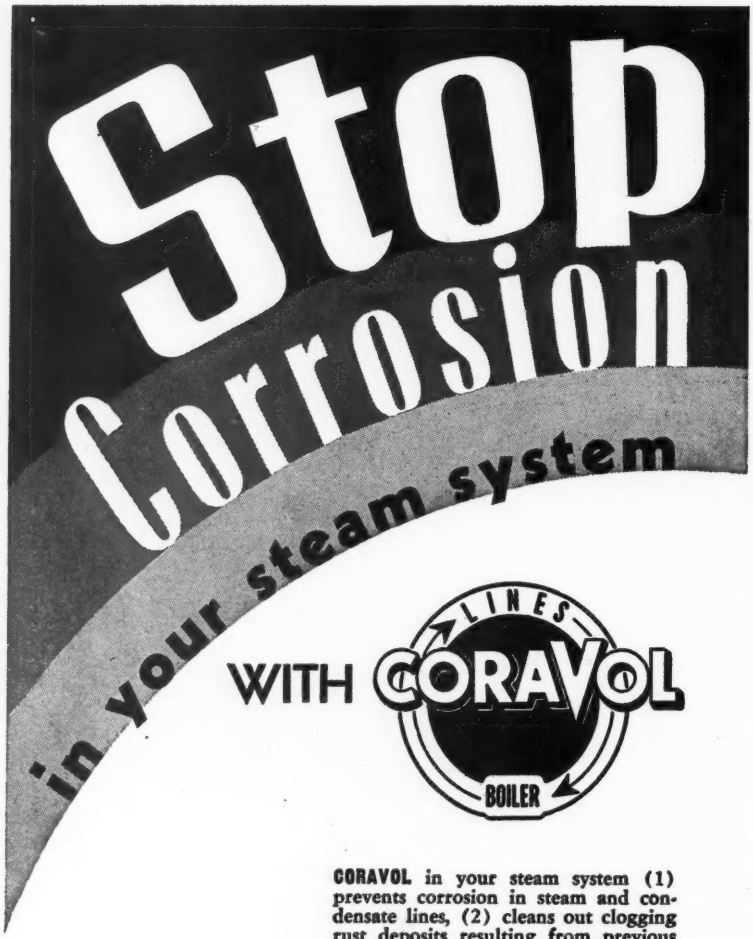
Result: A completely integrated package unit with a mighty saving in space. To install it you only had to connect the leads and it began to purr. Speaking of purring — you should have heard Mr. Compressor Builder when he saw the finished product.

There's a Moral: Every time Allis-Chalmers engineering solves *special* motor problems, we discover new ways to build better standard motors for you. Watch for these new and better motors from A-C.

Wait 'til you see the NEW

ALLIS-CHALMERS MOTORS!

HEAR THE BOSTON SYMPHONY: *Every Saturday Evening, American Broadcasting Co.*



CORAVOL in your steam system (1) prevents corrosion in steam and condensate lines, (2) cleans out clogging rust deposits resulting from previous corrosion. Thus, **CORAVOL** *protects lines;* increases effectiveness of heat transfer surfaces; restores original capacity of lines and the operating efficiency of valves and traps.

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KINGSLEY L. RICE,
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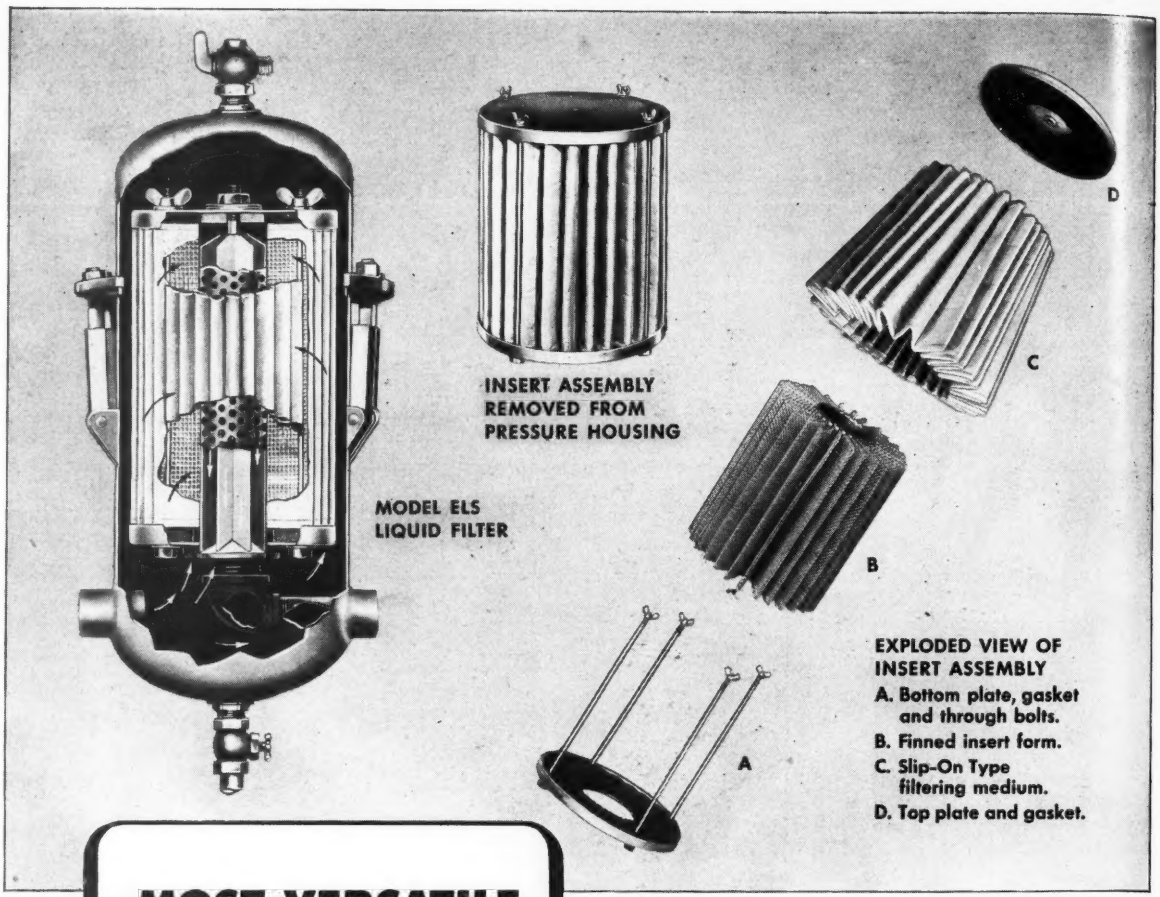

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level and smooth with the new . . .

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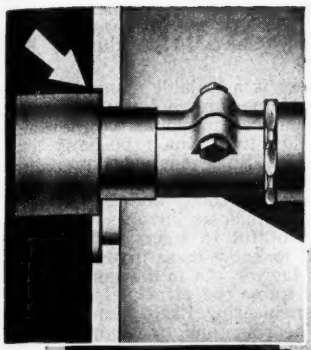

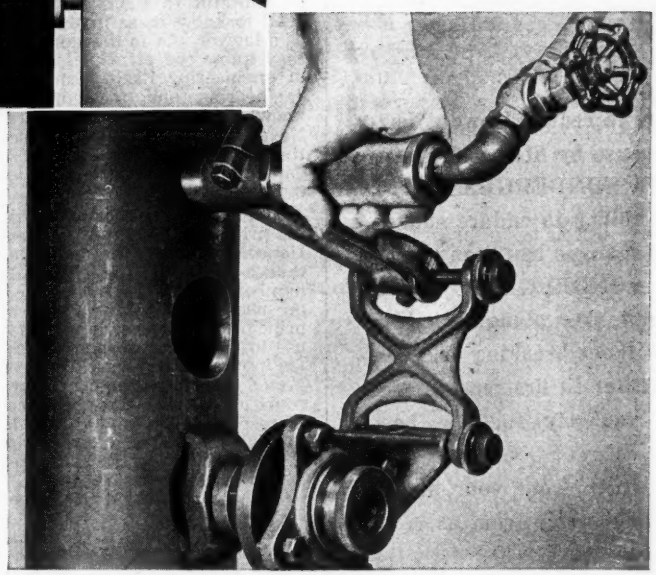

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Saves time loss in refacing handhole seats. Prevents leaks due to scarred seats.

Can be quickly clamped in place for use.

Can finish at one setting all seats wholly within 11½ in. radius of clamp center.

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This tool, now in use in many plants, has proven its value as essential boiler room equipment. Write us for full details.

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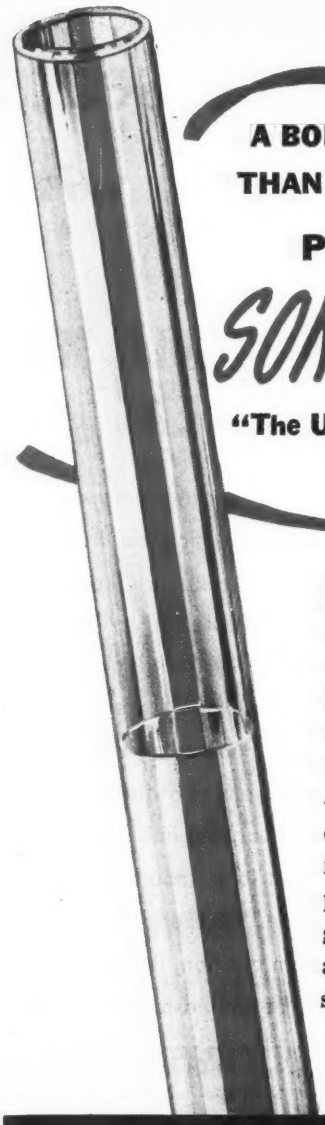

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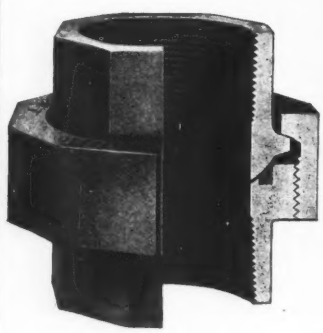

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New ENGINEERING BOOKS

Fundamental Business Law. By J. F. Christ. Copyright 1944; 5½ by 8½ in.; 332 pages; illustrated; cloth cover; published by American Technical Society, Drexel Avenue at 58th Street, Chicago 37, Illinois; price $3.00.

Here is a reliable summary of the most important and most frequently encountered principles of the law in relation to common business transactions. Since engineers are always engaged in such transactions, it would seem that some knowledge of the legal principles involved should be very useful to them. They do not need to know these in the same way as a lawyer, nor in the same way that they know the principles and details of engineering itself. In law, as in engineering and medicine, a little knowledge may be a dangerous thing. Nevertheless, some acquaintance with the fundamental principle of law is valuable in pointing the way towards more specialized knowledge.

The field of commercial law is vast, the principles numerous and complex. Hence, any book can be little more than a skeleton outline and a limited number of illustrations. The latter are necessary because a statement of principles alone can be of very little use to the practical man. Such illustrations and problems are given, digested or adapted directly from actual court decisions. The book contains more than statements about what the law is; it contains many instances in which the law is uncertain, in which it varies in different states,, or in which the services of an expert are required. Cases in which one should consult legal counsel are indicated in the book. Knowledge of the latter point is just about as important as knowledge of the law itself.

The chapters discuss the following subjects: The Formation of Contracts; Unenforcible Agreements of Competent Parties; Contractural Obligations; Contracts for the Sale of Goods; The Law of Agent and Principal; Law of Partnerships and Corporations; Law of Personal Property; The Law of Negotiable Instruments; Real Property Law; Law of Insurance; Employers' Liability for Injuries to Employees; Interpretation of Contracts, and Counterfeit Money.

The book is well illustrated with photographs and a number of good tabulations of data on particular points.

Piping Handbook. By Sabin Crocker. Copyright 1945; Fourth Edition. 4½ by 7 in.; 1376 pages; illustrated simulated leather binding; published by the McGraw- Hill Book Co.. 330 W. 42nd Street, New York 18, N. Y.; price $7.00.

To all engineers interested in piping design, the Piping Handbook has been a standard and very valuable reference work ever since the First Edition was published in 1930. With each succeeding edition it has grown in scope and authority. The present Fourth Edition is a still further improvement on its predecessors.

HEAT EXCHANGERS and OIL COOLERS

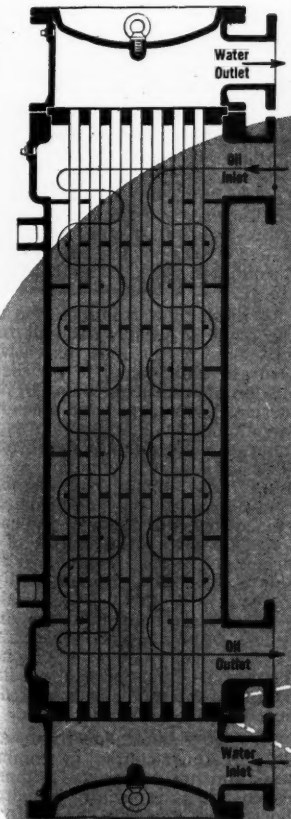
. . . engineered to out-perform

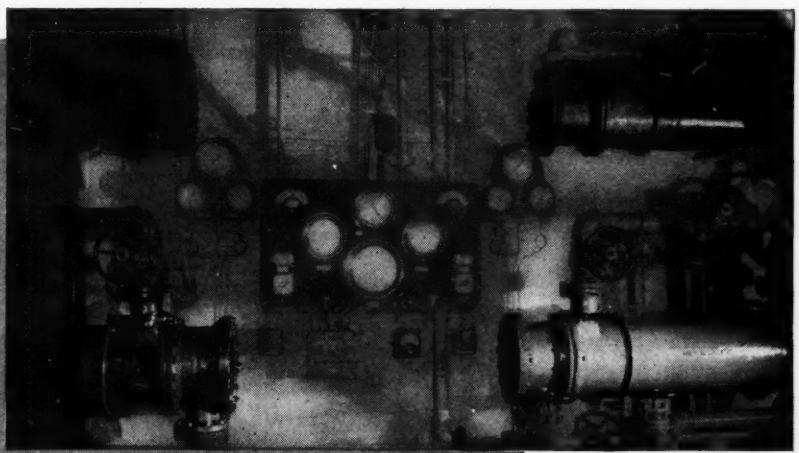
There are many reasons for the wide acceptance of SK Heat Exchangers and SK Oil Coolers in both marine and stationary installations. Ring and disc baffles, for example, provide a maximum of liquid travel and the greatest transfer of heat. The liquid is forced into zig-zag paths of equal length across the tube bundle, counter to the direction of flow in the tubes. Heat transfer is uniform, the temperature at corresponding points in all tubes is the same, and no stresses are set up by unequal expansion. Furthermore, there is no temperature stratification in the headers. Baffle rings, which alternate with discs, have center holes and extend to the full diameter of the shell. The external diameter of these baffles as well as the tube sheets is turned, after the tube bundle is assembled, to exact shell diameter so that a precision fit is made with the bored shell and no liquid can by-pass between shell and baffle.

Double packing rings, moulded in one piece, were developed by Schutte & Koerting to effectively prevent leakage of one liquid into the other at the floating tube sheet. If leaks should develop, the liquid passes outside of the shell and is a visible warning.

Channel box headers have separate covers which may be removed for inspection, cleaning and tube replacement. Pipe connections need not be disturbed.

Back of SK equipment is fifty years of experience. Each detail of construction is carefully planned for operating efficiency, long life and ease of maintenance. Call on SK engineers for assistance in heat exchange problems.





Cross section of SK Heat Exchanger shows ring and disc baffle construction, separate cover plates, and double packing rings between shell and floating tube sheet.

SK Heat Exchangers and SK Oil Coolers installed on Diesel driven ship.

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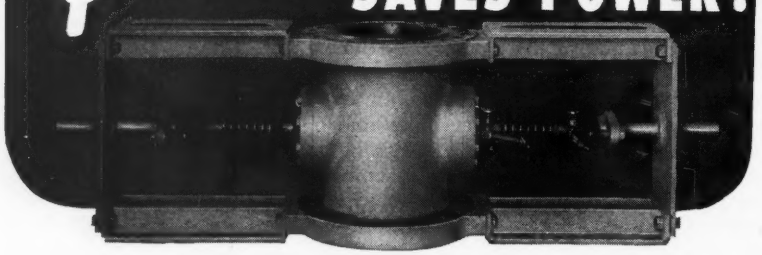

NO. 641—600-pound valve equipped with double-end shaft and dual finned stuffing boxes for super-heated steam at 540 psi.

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The opening or closing time of the vane in an R-S Butterfly Valve varies from one second to an interval of several minutes. Such quick or slow action, coupled with the natural low head loss due to the valve design, provides wide adaptability in the handling of a multitude of materials and a considerable saving in power on pumping operations.

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R-S Streamlined BUTTERFLY VALVES

In this edition, the scope of the book has been extended to include chapters on gas piping, refrigeration piping, hydraulic power transmission piping and corrosion, which also covers the subject of protective coatings. The chapter on water supply piping has been augmented, also the one on flow of water in pipes.

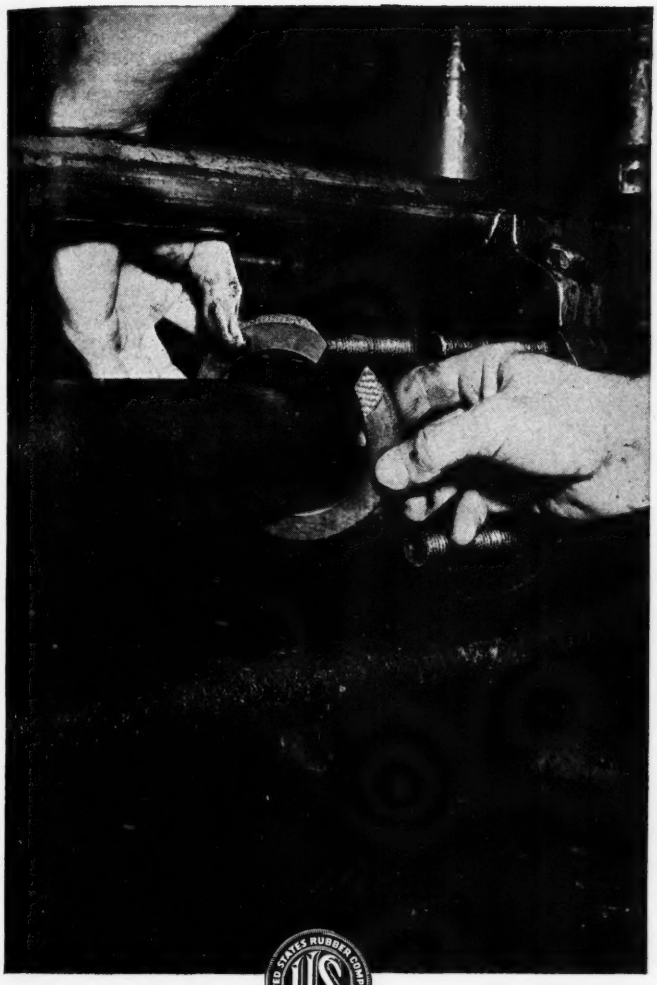
Mr. Crocker has included rather extensive discussions of the entire subject of fluid flow, elaborating particularly on the "rational formula" or Reynolds number type of solution and providing a variety of rational formulas in which all constants have been adjusted to suit a common friction factor f, which can be determined from tables and charts. He has also included an up-to-date discussion of the area-moment or grapho-analytical method for solving piping flexibility problems. Tables and charts have been improved, additional authorities cited, additional cross-references and an augmented index provided.

The various chapters in order treat the following subjects: Definitions, Formulas, and Tables; Fluids—Properties of fluids; Metallurgy of Piping Materials; Pipe, Valves and Fittings; Heat Insulation; Hangers and Supports; Expansion and Flexibility; Steam Power-plant Piping; Building Heating Systems; Plumbing Systems; Underground Steam Piping; Water-supply Piping; Fire-protection Piping; Oil Piping; Gas Piping; Refrigeration Piping, Corrosion; Hyraulic Power Transmission Piping.

The Art of Burning Coal, in three volumes; by Loyd R. Stowe; copyright 1944; first edition; 8½ by 11 in.; total of 280 pages; full size typewritten pages reproduced by planograph printing; paper covered; published by Loyd R. Stowe, 308 W. Washington St., Chicago 6, Ill. Price, $15.

In these three volumes, the author has made a serious attempt to analyze some of the most extensive and accurate data compiled on the combustion of American coals. In his discussions he has separated the performance of the firing equipment as something that develops heat from the performance of the boiler as something quite apart from combustion conditions, he has determined the "unaccounted for losses," indicated in a practical way the causes of these large fuel losses, established a procedure whereby all can verify the correctness of the losses revealed by U. S. Government bulletins and by other test data, clarified somewhat the maze of true and false notions about coals, and determined in considerable detail the causes of fly ash emissions from chimneys.

This set of books constitutes a complete reading course in combustion based on an extensive original research and is especially prepared for those who generate considerable steam. In all there are 20 sections in which the author outlines combustion engineering and boiler room testing; points out the significance of CO_2 in flue gas; indicates how combustion results are affected by rates of heat release; discusses fuel bed control; considers the heat absorbing characteristics of the boiler; coal characteristics and fuel burning equip-



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Carefully checked records of this U. S. PEERLESS CROSS EXPANSION PACKING have verified every claim of satisfactory packing performance against medium or low-pressure steam, hot or cold water, ammonia, alcohol, light and mineral seal oils.

It is another example of the benefits gained by applying exact rubber technology to the practical needs of industry.

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PACKING QUICKLY REPLACED—Available in sizes ¼" to 1½" inclusive, U. S. PEERLESS CROSS EXPANSION PACKING is applied quickly and easily. Furnished in spiral, coil or ring form.

U. S. PEERLESS CROSS EXPANSION PACKING—("U. S." Style No. 231) is made of diagonally laid plies of highest quality closely woven duck, bonded together with a special "U. S." rubber compound and thoroughly lubricated and graphited. It has excellent aging qualities.

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MURRAY
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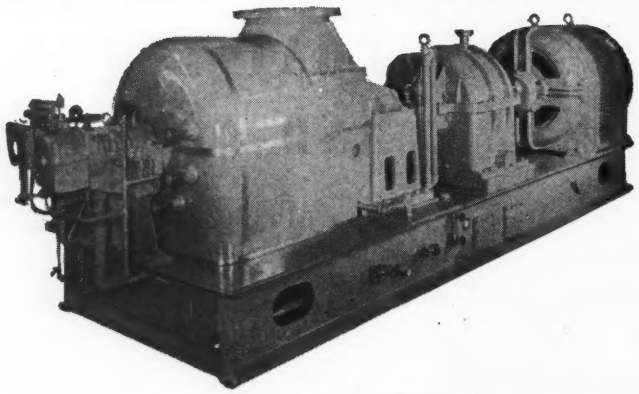

500 KW—PACKAGE TYPE

The unit shown above was designed to deliver 500 KW 50 cycle alternating current on steam at 285# gauge, 700 degrees F., and exhausting condensing to 27 inches vacuum. Thirty identical units were furnished.

Equipment included trip and throttle valve, oil relay governor controlling single throttling inlet valve with hand valve control for partial load operation, all service connections above floor line except generator leads, drain piping brought to one point, and structural steel baseplate. The baseplate is sufficiently rigid so that the unit can be handled in one piece, and installed on the simplest of foundations.

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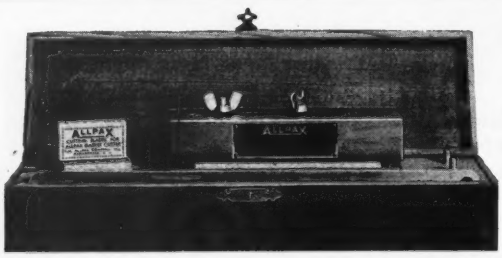

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ment are analyzed; smoke and furnace losses are correlated; description is given of the design, application and use of modern firing equipment; causes and extent of fly ash emission are cited; over fire air is discussed; gives directions for controlling combustion; the significance of stratification, turbulence and simple mixing of furnace gases is treated; pointers on furnace design are given; and discussions on the applicability of various types of modern fuel burning equipment to fuels and boilers are included. These volumes are devoid of higher mathematics and involved chemistry but treat the subject thoroughly and in a manner understandable to anybody at all familiar with combustion problems.

Diesel Fuel Injection Systems, by Louis R. Ford. Copyright 1945; 4½ by 6 in.; 175 pages; paper binding. Published by Diesel Publications, Inc., 192 Lexington Ave., New York 16, N. Y. Price $1.00 in the United States, elsewhere $1.25.

In the Foreword of this informative and helpful book, the author explains that the fuel injection pump must inject an accurately metered quantity of fuel into the cylinder at regular intervals. Even medium speed engines of the 2-cycle type, operating at 500 rpm, require over eight injections per second for each cylinder. Watchlike precision is therefore necessary. He emphasizes that "know how" is the prime requisite for safe and correct maintenance of injection units. The purpose of this book is to provide a handy means for the operator of Deisel engines to obtain an understanding of the essentials of the fuel system of any American built Diesel engine that he may be called upon to operate. With that in mind, each of the injection systems used in American practice is described in detail, in each case the specific features of the pump, injector, maintenance and testing are carefully described. The final chapter is on the servicing of fuel injection nozzles and is close to a manual on the subject. Any operator will find this book an extremely useful reference book, first it should be read and then consulted whenever his fuel system needs attention.

Fuel Savings Resulting from Use of Insulation and Storm Windows by Alonzo P. Kratz and Seichi Konzo, Bulletin Series No. 355, Volume 42, No. 7, price 40 cents. **Heat Emission and Friction Heads of Hot-Water Radiators and Convectors** by Frederick E. Giesecke and Alonzo P. Kratz, Bulletin Series No. 356, Volume 42, No. 22, price 50 cents. **A Study of Radiant Baseboard Heating in the I-B-R Research Home** by Alonzo P. Kratz and Warren S. Harris, Bulletin Series No. 358, Volume 43, No. 4, price 35 cents. **The Viscosity of Gases at High Pressures** by Edward W. Comings, Bertrand J. Mayland and Richard S. Egly, Bulletin Series No. 354, Volume 42, No. 15, price 75 cents. **An Analysis of the Motion of a Rigid Body,** by Edgar W. Suppiger, Bulletin Series No. 353, Volume 42, No. 44, price 75 cents.

All the above published by the University of Illinois, Urbana, Illinois.

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For bulk coal movement

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horizontal-

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conveyor is the G-W

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WHERE bulk coal movement from track hopper to storage requires inclines up to 45°—too steep for apron or belt conveyors but not steep enough to require elevators—G-W Flight Conveyors do the job with maximum economy. They are equally efficient and widely used for transporting coal horizontally and distributing it over ground storage or bunkers. Size and type (single or double chain) are determined by capacity and size of lumps to be handled. G-W offers a full line of standard types, or will design flights to fit unusual layouts.

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With 130 years of specialization in the design, construction and installation of conveyors, carriers, skip hoists and elevators, Gifford-Wood is particularly well qualified to advise you on a complete system for coal- and ash-handling that will best meet your needs. Plan today and profit tomorrow with modern, efficient and economical G-W conveying equipment.
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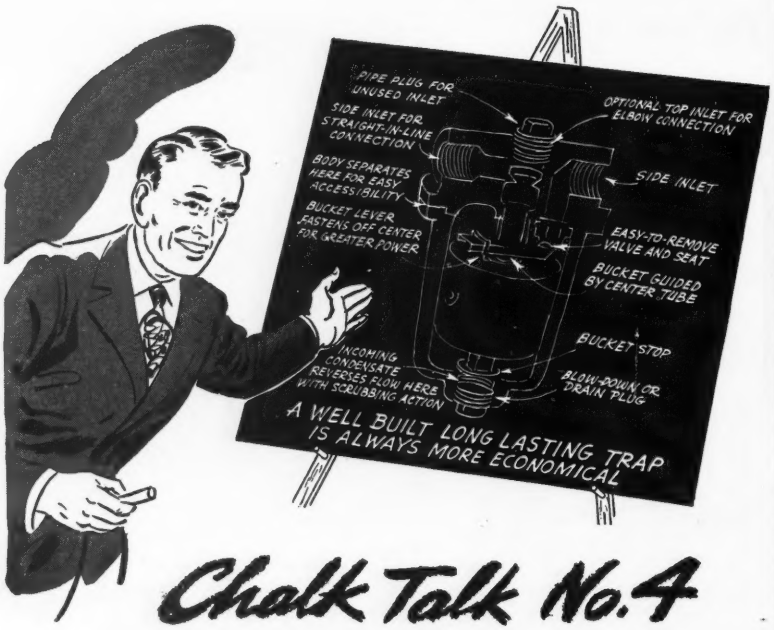
PIPE PLUG FOR UNUSED INLET
SIDE INLET FOR STRAIGHT-IN-LINE CONNECTION
BODY SEPARATES HERE FOR EASY ACCESSIBILITY
BUCKET LEVER FASTENS OFF CENTER FOR GREATER POWER
INCOMING CONDENSATE REVERSES FLOW HERE WITH SCRUBBING ACTION
OPTIONAL TOP INLET FOR ELBOW CONNECTION
SIDE INLET
EASY-TO-REMOVE VALVE AND SEAT
BUCKET GUIDED BY CENTER TUBE
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BLOW-DOWN OR DRAIN PLUG
A WELL BUILT LONG LASTING TRAP IS ALWAYS MORE ECONOMICAL

Chalk Talk No. 4

ON POSTWAR STEAM TRAP ECONOMY

In previous Chalk Talks, we told you about the economy of simplified piping, the low first-cost for installation, and the savings in inspection of Anderson Super-Silvertop Steam Traps . . . Now we want to point out the economies in the construction features of Super-Silvertop Steam Traps as shown in the above diagram.

Super-Silvertops are exceedingly strong. Their castings are of nickel semi-steel, the bucket and guide tube of copper and bronze, with all working parts of stainless steel. There are no pins to wear out and all working parts ride on knife edge contact, which eliminates practically all friction. And finally there are no restricting passages to become clogged with scale. These construction features of Super-Silvertops make for years of economical service.

THE V. D. ANDERSON CO.
1939 W. 96 Street • Cleveland 2, Ohio

Super-Silvertop
STEAM TRAPS

JOHN PHILLIPS BADENHAUSEN
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43 Years Experience in Power Plants

BADENHAUSEN BOILERS • SUPERHEATERS
FIRING SYSTEMS • SAWDUST BURNERS

After consulting us, a coke company in Philadelphia doubled the steam output of its boilers. Additional steam was made in the furnaces, with no increasing draft loss and no loss in efficiency. And no costly new investment in boilers, housing, stacks, etc.

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DESIGNERS, draftsmen, piping and equipment post-war steam-electric plants. Chicago location. Laramore and Douglass, Inc., 327 S. LaSalle St., Chicago 4, Ill.

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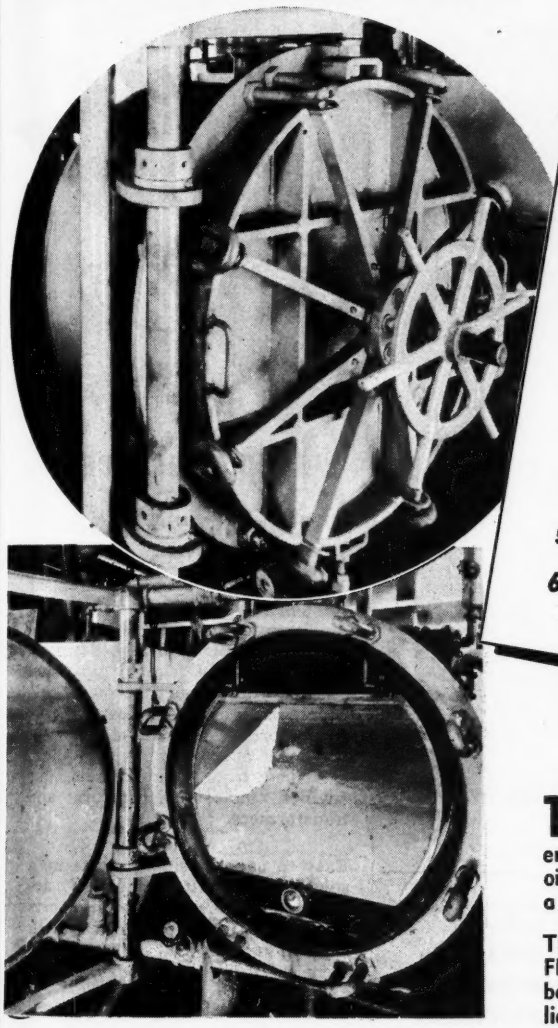
AND KEEP THE BONDS YOU HAVE

Removes ALL OIL from condensed returns used for boiler feed



Upper picture shows the Refiner with special quick-locking door in place. Lower photo shows door open. Note how filter bed is peeled easily from pressure leaves in one piece.

The REFINER

A revolutionary new filter PROVEN IN SERVICE

1. Eliminates oil entering boilers. Improves boiler efficiency. Reduces boiler maintenance costs.
2. Saves heat units and fresh water by clarifying contaminated returns formerly dumped.
3. Removes free and EMULSIFIED oil from water to less than one-tenth part per million.
4. Requires no chemicals or wasteful back-washing.
5. Is simple, inexpensive to operate.
6. Requires little space.

THE REFINER is an outstanding achievement in filters designed for extremely fine filtration. It breaks the tightest emulsion in condensate and removes both emulsified and free oil from an oil content as high as 90 parts per million down to a guaranteed maximum of one-tenth ppm.

The REFINER features compactness and low-cost operation. Flow rates of 20 to 200 gpm are obtained in single units. A battery of units provides greater capacities. The cost of filtered liquid by this new method of emulsion breaking is extremely low. No back-wash water is used.

The REFINER will greatly step up the efficiency of your plant and reduce boiler maintenance costs. Engineering assistance will be furnished gladly.

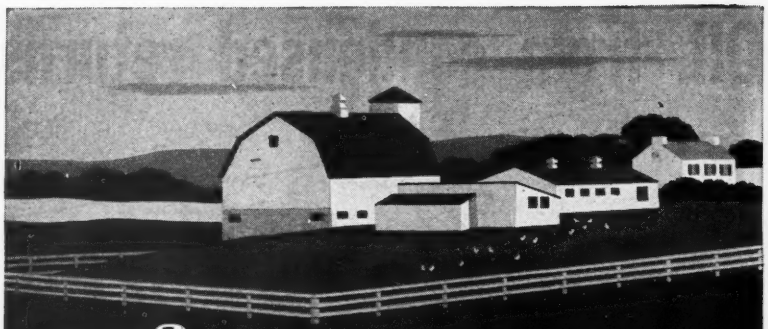
Write for Catalog

APPLICATIONS

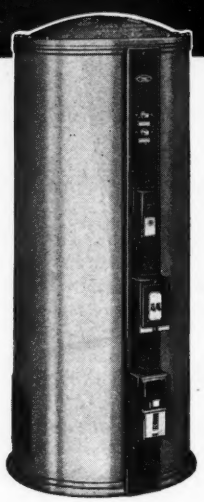
The REFINER can be used as a polishing filter for practically any liquid, including boiler feed water and condensate, alcoholic, malt and other beverages, chemicals, aromatics, paints, varnishes, lacquers, soaps, detergents, juices and liquid foods, and liquids used in processing other substances. The pressure-tight cylinder permits filtration of volatile, inflammable, and hazardous liquids. It also removes turbid matter of the same specific gravity as the liquid.

BLACKBURN-SMITH
MANUFACTURING COMPANY, INC.
For 60 years designers and manufacturers of filters
66 River Street, Hoboken, N. J.

Blackburn-Smith Mfg. Co. is a wholly owned subsidiary of Condenser Service & Engineering Co., Inc., builders of Evaporators, Stage Heaters, Gas Coolers, Drain Coolers and Heaters, Aftercoolers, Air Preheaters, Fuel Oil Heaters, Jacket Water Coolers, Process Heat Exchangers, Transformer Oil Coolers, Generator Air Coolers, Lubricating Oil Coolers, Storage Tank Oil Heaters, Feed Water Heaters, Distillers, Industrial and Oil Refinery Heat Exchangers, and other type of heat exchange equipment.



15¾ acres of purifying surface in every pound of fuller's earth used in a HONAN-CRANE PURIFIER



THE exceptional filtering capacity of Honan-Crane Purifiers is due in large part to Honan-Crane's ability to use loose fuller's earth as the filtering medium. A Honan-Crane Purifier for an average size Diesel would contain approximately 88 lbs. of fuller's earth, providing 1,386 acres of filtering surface.

The highly successful performance of Honan-Crane Purifiers is attributable to their unusually great filtering capacity, plus the fact that fuller's earth is the best known medium for the *complete removal of all types of damaging contamination from lubricating oil.*

Honan-Crane Purifiers, using fuller's earth, will remove the most microscopic solid and will also completely remove acids and other forms of soluble contamination.

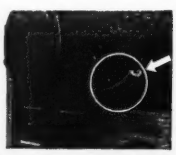
Write for engineering and equipment bulletins giving complete specifications on Honan-Crane Purifiers for Diesel or any other kind of industrial oil.

HONAN-CRANE CORPORATION
301 Indianapolis Avenue, Lebanon, Indiana

Subsidiary of ***HOUDAILLE-HERSHEY CORPORATION***

"Boiler Repairs Reduced 75%"

writes user of **NATIONAL GIRTH SEAM PROTECTOR**



We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

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MORE POWER

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Easy Way to Keep Equipment Surfaces Clean

The brilliancy of your power plant equipment when it's new . . . you can keep it that way with Oakite Renovator. Scientifically designed to bring out the original gloss and color in your painted surfaces, this widely-used material cleans safely . . . thoroughly. Grease, oil, dirt and other accumulations are quickly wiped from your Diesels, gas engines, motors, generators and transformers.

Easy to use . . . simply make up a solution of Oakite Renovator, approximately one part to four parts water, and then wipe surfaces with a solution-moistened cloth. Equipment is left with that well-groomed look that expresses efficiency.

Send for FREE Digest!

This low-cost paint restoring job is but one of over 70 different power plant maintenance cleaning tasks contained in a 20-page Digest specially prepared by Oakite and distributed FREE for the asking. Ask us to send you a copy TODAY!

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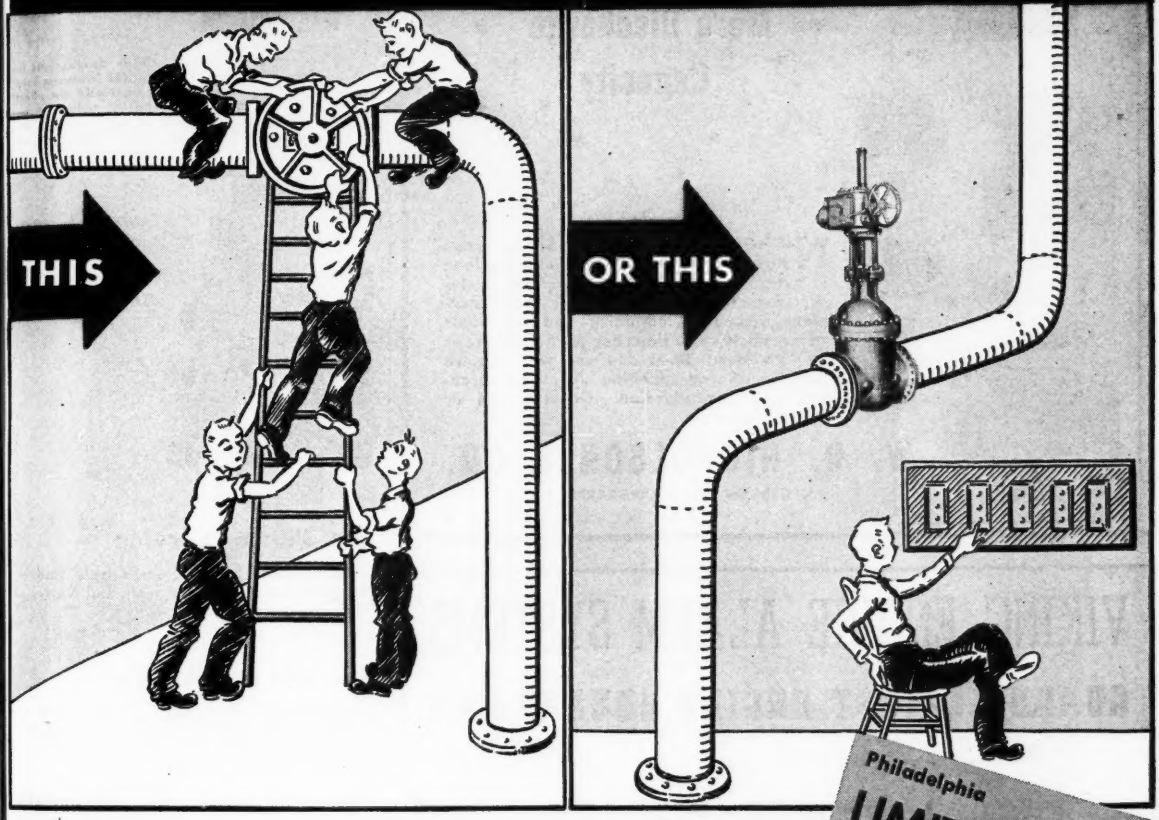
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

WHICH

SAVES TIME
SAVES TROUBLE
PROVIDES GREATER SAFETY



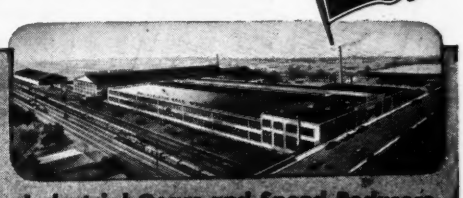
Philadelphia
LIMITORQUE
VALVE CONTROLS

The striking contrast between opening or closing similarly sized valves manually or with LimiTorque Valve Operators is clearly demonstrated in these drawings. LimiTorque Controls enable one man to operate valves up to 96" diameter by merely pushing a button at a centrally located master control panel or a convenient individual push button station. This permits the valve to function at maximum desired speed while eliminating all physical hazards to the workmen.

Remote operation of valves from one central point with a full knowledge of their status at all times is entirely practical with LimiTorque. There are several types of LimiTorque Controls applicable for operating all types and sizes of valves and which can be adapted to existing equipment if desired. Floor stand controls can be furnished where it is not practical to fit the controls directly to the valve yokes.

Write us for more details . . . on your business letterhead, please

ARMY (E) NAVY



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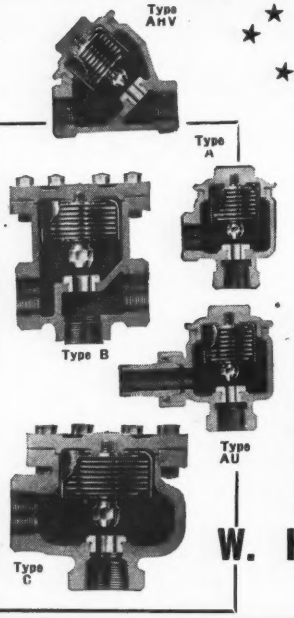
Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Plant tests show these

NICHOLSON TRAPS



HAVE

2 to 6 Times More Discharge Capacity

NICHOLSON Thermostatic Steam Traps have orifices 4 to 16 times larger than in average traps. This is one of the exclusive features that account for their enormous discharge capacity and for their quick, positive action. Use Nicholson Traps on "problem" lines and see why they're well-known for speeding up steam circulation and production. Catalog 444 or see Sweet's.

W. H. NICHOLSON & CO.

160 OREGON ST., WILKES-BARRE, PA.

VIKING ENGINE ALARM SYSTEMS

GUARD AGAINST ENGINE BREAKDOWN

from:

1. EXCESSIVE TEMPERATURE OF CIRCULATING-WATER SYSTEM
2. INSUFFICIENT PRESSURE IN LUBRICATING-OIL SYSTEM

WRITE FOR DATA SHEETS M-3 and M-3B

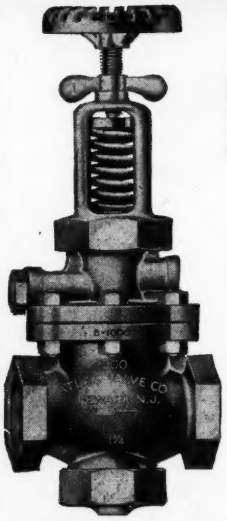
Every diesel and gas engine should be properly protected with a Viking alarm system. Viking is a *complete system*, no extras to buy. When water temperature becomes too high or oil-pressure too low, howler sounds to warn operator of danger. Type M-3B provides visual indication of source of trouble, also Heavy-duty construction, factory-set for your own requirements.

VIKING INSTRUMENTS, INC.
403 Fairfield Ave. Stamford, Conn.

ATLAS

"Type B"

STEAM REDUCING VALVES



Wide fluctuations in initial pressure have practically no effect on the reduced pressure because of the pilot operation of this valve.

Write for Bulletin No. 1A giving complete details.

For 300 lb. Service

All Bronze—Screwed or Flanged Ends—Bronze or Nickel Alloy Seats and Valves—Pilot Operated. Sizes: ½", ¾", 1", 1¼", 1½", 2".

For 250 lb. Service

Iron Body — Flanged Ends — Bronze or Nickel Alloy Seats and Valves—Pilot Operated. Sizes: 2½", 3", 4", 5", 6", 8".

For 400 and 600 lb. with Temperatures to 900° F.

Series 40 for steam service to 400 lb.
Series 60 for steam service to 600 lb.

Steel Body—Monel Metal, Stainless Steel and Nitralloy Seats—Stainless Steel Piston and Piston Chamber—Flanged Ends—Pilot Operated. Sizes: ½", ¾", 1", 1¼", 1½", 2", 3", 4", 6".

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- ☐ Reducing Valves
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- ☐ Temperature Regulators
- ☐ Exhaust Control Systems
- ☐ CAMPBELL Boiler Feed Water Regulators
- ☐ Pump Governors
- ☐ Pressure Regulators
- ☐ Float Valves
- ☐ Oil Control Cocks
- ☐ Humidity Controllers
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REGULATING VALVES FOR EVERY SERVICE

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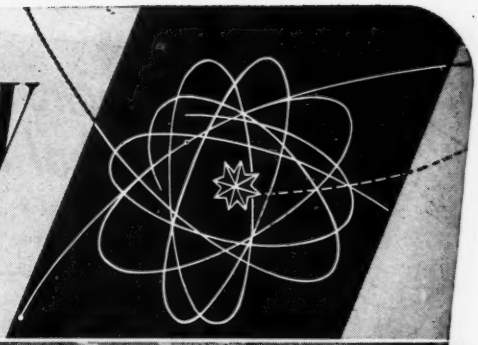
Atomic Energy

the composite answer to a myriad scientific and technical questions



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Marley COOLING TOWERS

were the correct solution to major water-cooling problems

PRODUCED BY

THE MARLEY COMPANY KANSAS CITY KANSAS

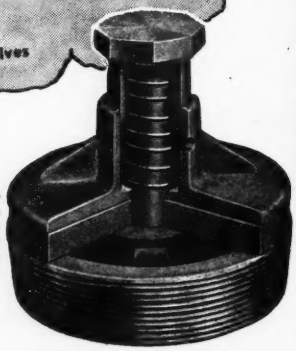
"No Pump Valve Repairs in 5 Years Plus a Good Coal Saving"

Reports Engineer Hugo Beck
After Using COMBINATION Valves

When fitted with old-style valves, two vacuum pumps at the Eisendrath Glove Co., Chicago, had to be taken apart at least four times during each heating season. Besides the expense of over-hauling, they were inefficient—had to click off 80 strokes a minute to maintain a 7½ in. vacuum.

After facing the seats of these two pumps and fitting them with 24 non-tilting COMBINATION Pump Valves, the engineer, Hugo Beck, said: "Keeping a 26 in. vacuum now is easy as pie. And the continuous straight-lift action of these valves is helping us save quite a little coal a day."

What COMBINATION Pump Valves are saving for hundreds of other plants they can save for you. They close quickly, reduce wear, prevent slippage, make steam do more work. Seat, stud and spring are made of long-lasting Phosphor Bronze. Widely used for Boiler Feed, Vacuum, Condensate and General Use Pumps.



For Boiler Feed, Vacuum, Condenser General Service Pumps

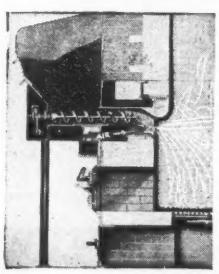
They match the satisfaction delivered by COMBINATION Silent Check Valves.

COMBINATION PUMP VALVE CO.
846 WIOTA STREET, PHILADELPHIA 4, PA.

FYR-FEEDER MULTIPLE SPREADER STOKERS

BURN COAL LIKE OIL!

Save with FYR-FEEDER—Burn less coal—Cheaper coal—Local coals—Screenings—Coal Yard Sweepings, wet or dry—WET coal is no handicap.



FYR-FEEDER Exclusively employs air JET coal PROPULSION

Fines burn in suspension, larger pieces are spread evenly over grate.

FYR-FEEDER increases boiler capacity—responds instantly to sudden load variations—requires no special skill or experience to operate—thin fuel bed eliminates clinkers—makes fireman's work much easier—no banking losses.

CHANGE OVER TO FYR-FEEDER NOW

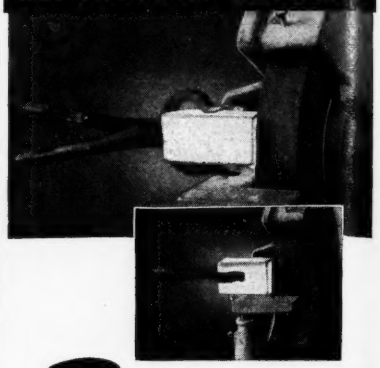
Easily installed in minimum time

FYR-FEEDERS are built in sizes to burn from 300 to 12,000 lbs. coal per hour. If you are or expect to be in the market for automatic coal burning equipment

Wire or Write
FYR-FEEDER Stoker Division
AMERICAN COAL BURNER COMPANY
Engineers

22—19 E. Erie St. Chicago 11, Ill.

BRICKSEAL
REFRACTORY COATING

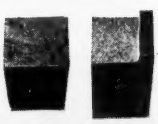


Resists
ABRASION

PROTECTION against abrasion is an outstanding advantage of Brickseal. Here are two refractory bricks, one coated with Brickseal, the other uncoated. They were heated to more than 2000°, taken directly from the furnace and shoved against an emery wheel. Hot and cold, the Brickseal-treated brick resisted the abrasion – see below.

Brickseal consists of high fusion clays and metal oxides combined in oil. Furnace heat burns away the oils and vitrifies the clays and metals which penetrate deeply into the pores, cracks and joints. Brickseal prevents cracking, spalling and slagging regardless of sudden temperature changes. Brickseal is also a mortar for laying up refractory walls.

Compare the Brickseal-treated brick at the left to the untreated at the right.



TRY IT YOURSELF
on your emery wheel

Two bricks bonded together and partially coated with Brickseal will be mailed to you on request.

BRICKSEAL
REFRACTORY COATING
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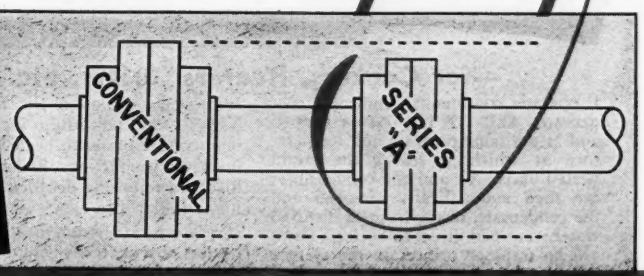
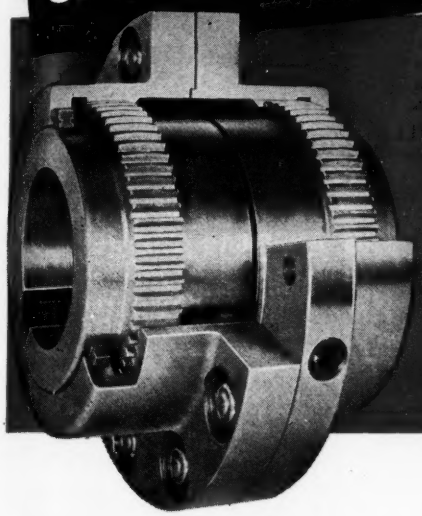
1029 Clinton St., Hoboken, New Jersey

Now.. YOU CAN USE *Smaller Size Couplings*

SAVE
COST · SPACE
SHAFT EXTENSION





New "Series A"
WALDRON
Gear Type **COUPLING**

- Made of all forged steel to close manufacturing tolerances.
- No flexible hub connections to fatigue, such as rubber bushings, spring grids, flexible pins, laminated discs, etc.
- Positive dust and oil proof Waiflex Seal.
- Freedom of movement between cover sleeve and hub prevents stress on shaft and bearings.
- All metal to metal contacts between hub and cover sleeves are automatically lubricated to prevent wear.

Reducing costs to coupling buyers without sacrificing any of the basic design refinements characteristic of Waldron Gear Type Couplings is a noteworthy new achievement of Waldron Engineers.

The new "Series A" Waldron Coupling is designed for a much larger maximum bore that now permits use of smaller sized couplings than are ordinarily required. To coupling users this means welcome savings in unit costs, in space and shaft extension which combine to make a neater, more compact and more economical installation.

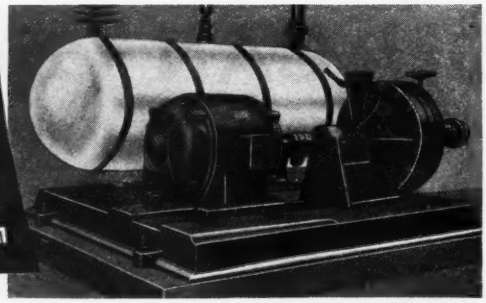
The Waldron "Series A" Coupling embodies all the design refinements that have made Waldron Couplings famous. From every standpoint—first cost, maintenance expense, operating advantages, space requirements—it easily proves the most economical coupling to buy and use.

Design and construction details, rating tables, service factors and prices will be furnished on request.

(COUPLING DIVISION)

JOHN WALDRON CORP.
Main Office & Works – NEW BRUNSWICK, NEW JERSEY
SALES REPRESENTATIVES IN PRINCIPAL CITIES

Increase
YOUR PRODUCTION
with the
STOUT NO-VENT
Boiler Return System



—for Cookers, Heaters, Driers, etc.

It operates continuously returning condensate, ALL OF IT, fast as formed and at the same pressure and temperature at which it leaves the steam heated units. Air and non-condensibles are then automatically removed and the condensate, in the form of distilled water, returned direct to boiler. There are no traps or orifices in the system.

High temperature direct return saves fuel. Often 25% or more. (This would offset the 20% cut expected in soft coal deliveries to industry as announced July 14th by Secretary Ickes.)

Improved circulation the Stout NO-VENT way uniformly increases the temperature in steam heated units and increases production. Reducing boiler load and returning distilled water prolongs boiler life.

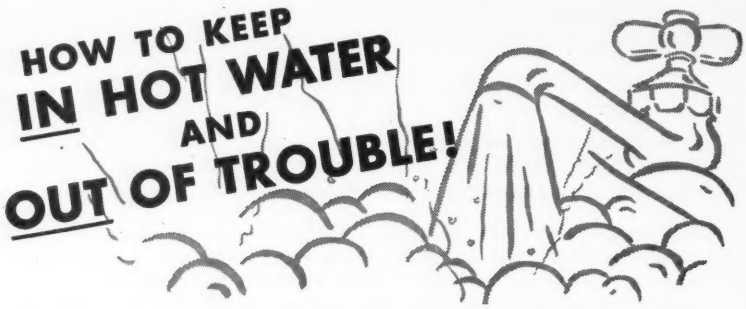
If you operate steam heated cookers, heaters, driers, ironers, clothing presses, drying ovens, oil tanks, water tanks, pickling tanks or have other uses for so-called "process steam" investigate the Stout NO-VENT Boiler Return System. It can boost your production.

DAVID STOUT & SONS • 6 N. Michigan Ave. • CHICAGO 2, ILL.
Heat Reclaimers • Steam Condensers • Spiro Water Heaters • Gas Fired Boilers

Write for bulletin showing hookup of Stout NO-VENT System and giving operating details. Made in capacities 100 to 800 bhp, pressures to 200 lb. Distributors will be interested in selling franchise.

Stout
NO-VENT BOILER RETURN SYSTEM

HOW TO KEEP IN HOT WATER AND OUT OF TROUBLE!



• Where it's essential to keep a steady supply of hot water, install the MARION GULF STREAM HOT WATER HEATER. Indispensable to hotels, office and apartment buildings, large institutions, and factories of all kinds where abundant hot water is essential and steam is available.

Construction is simple. Water is heated faster through intimate contact with steam chambers adjoining. Internal parts float independently, avoiding strain from rapid contraction and expansion.

Low pressure steam is utilized with greatest economy. Inexpensive investment. Capacities range from 370 to 3700 GPH. Instantaneous type but can be used with storage tank.

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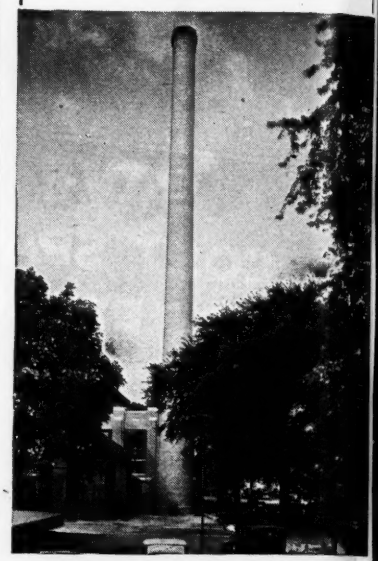

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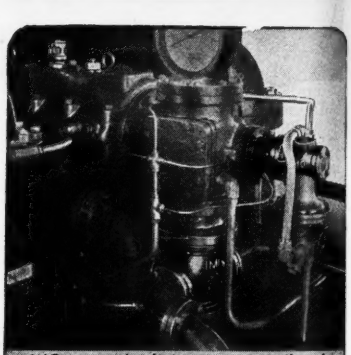

IMO pump circulating governor oil and lubricating oil for large turbine.

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The IMO PUMP requires less space than most other pumps because of the high capacity attainable by its efficient, compact design and high speed operation. If desired, it can be directly connected to, and mounted upon, turbines, motors, engines, or other equipment. In special designs, dimensions and proportions can be varied to meet space limitations.

For information send for Catalog 1-128-C

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PUMP DIVISION OF THE
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

"LOW STEAM CONSUMPTION MAINTAINED"

reports the city of Corbin, Ky., of their 1500 KW Worthington-Moore Turbine Generator.

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Commissioner of Finance

BERT ROWLAND, Mayor

Power and Water Department
CITY OF CORBIN
H. C. CRAFT, Superintendent

JOHN V. WALKER
Commissioner of Public Works

Corbin, Kentucky

Worthington Pump and Machinery Corporation
Eight and Race Streets
Cincinnati 1, Ohio

Dear Sirs

Attention-Mr Earle W. Vinnedge
Manager
Cincinnati District Office

You will recall that when our 1500 KW turbine generator unit which we purchased from Worthington was installed 4½ years ago it was necessary for us to immediately put it in service due to load demands without the usual tune up period. Since then the unit has been in practically continuous service and now that we are in a position to do so we have decided to open the turbine for inspection.

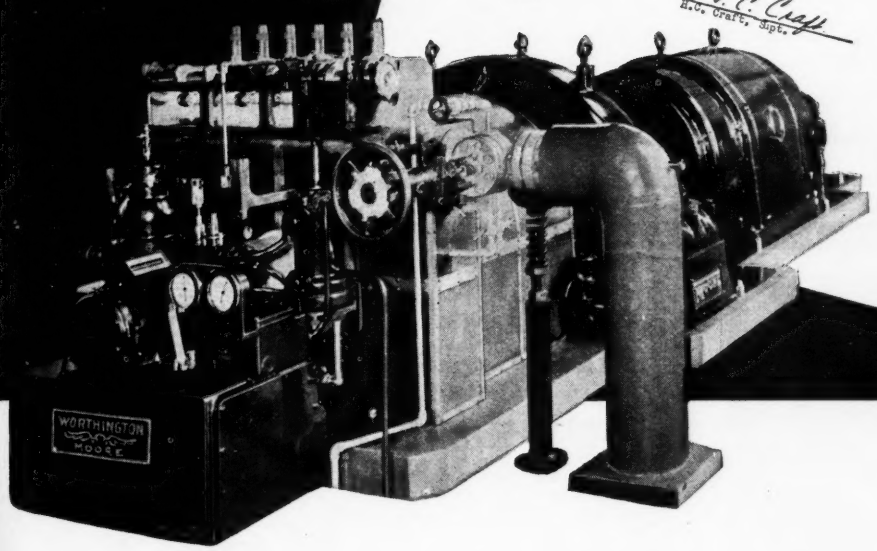
We believe that you will be interested to know that except for routine adjustments maintenance has been negligible and the original low steam consumption has been maintained. We are very pleased with the service and economical operation this unit has given us and the interest you have shown.

Yours very truly,

CITY OF CORBIN
POWER and WATER DEPT.

MF/HCC

H.C. Craft, Supt.



Low maintained steam consumption, freedom from operating troubles and the ability to be placed in continuous service immediately after erection without a "tune-up" period are typical characteristics of all Worthington Turbine Generator units. This is made possible by our practice of testing the complete unit under operating steam conditions and load at our works before shipment . . . Write today for Bulletin 1960 . . . further proof that *there's more worth in Worthington*. *Worthington Pump and Machinery Corporation*, Moore Steam Turbine Division, Wellsville, N. Y.

WORTHINGTON

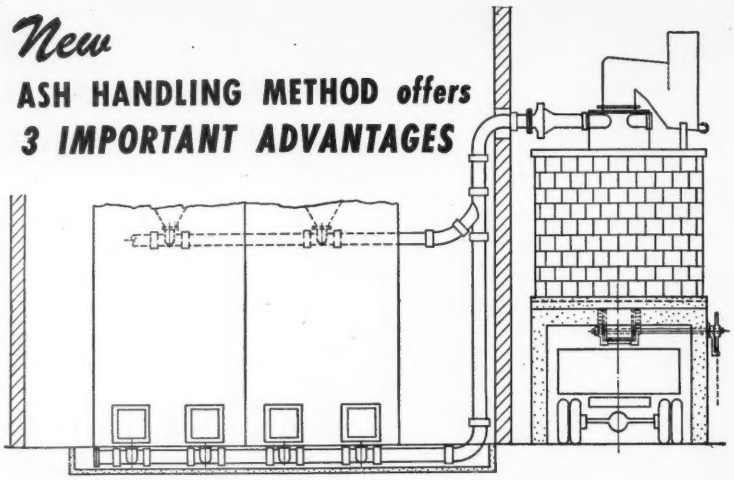
T5-2

A GREAT TEAM IN STEAM

New

ASH HANDLING METHOD *offers*

3 IMPORTANT ADVANTAGES



In the Beaumont "Vac-Veyor" pneumatic ash handling system the exhauster, receiver, separator and air washer are combined as one unit. Operating advantages include: (1) All ash delivered into the silo, none into the air. (2) Ashes delivered practically dry, which minimizes the possibility of packing or freezing in the silo. (3) Continuous operation, with low steam consumption. What are your ash handling problems? Send today for literature.

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Phosphates **Dissolved Oxygen**
Chlorides **Sulfates**
Total Alkalinity **Hardness**
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LaMotte
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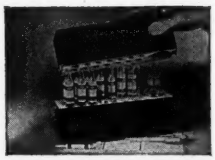

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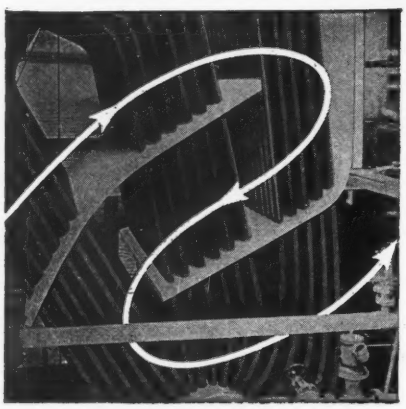

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILER PLANT

1 **Refractories for Industrial Furnaces**—Bulletin No. 845, with many diagrams and sectional views, tells advantages of the Durabilt arch suspended directly from supporting brackets; said to reduce installation and maintenance costs in industrial furnaces. Chicago Fire Brick Co.

2 **Oil And Gas Burners**—New Catalog No. 45 describes Faber Burners for pulverized coal, light and heavy oils, tar or acid sludge, gas; also for various combinations of these fuels. Designed for manual or automatic control; capacities up to 1000 gph. Faber Engineering Co.

3 **Soot and Fire Scale Remover**—Bulletin explains how Soot-Off is used as a soot and fire scale remover in all types of boilers. Also lists other Alken products to increase boiler efficiency and simplify building maintenance. Alken-Murray Corp.

4 **Self-Contained Steam Generator**—Bulletin describes operating features, gives ratings and dimension of Cyclotherm steam generator. This unit is self-contained, fully automatic, burns any liquid or gaseous fuel, capacities from 10 to 200 hp. Cyclotherm Corp.

5 **Hydroseal Ash Pumps**—Catalog No. 141 gives operating details, sectional diagrams, sizes, capacities and other useful handbook data on the hydrojet system of ash disposal. These pumps handle ashes from stoker-fired, dry bottom powdered coal-fired, and slagging furnaces. Allen-Sherman-Hoff Co.

6 **Forward Moving Grate Stoker**—New catalog describes construction and advantages of Detroit RotoGrate stoker in which the grates move forward slowly and continuously discharge the ash at the front. Gives interesting pictorial review of recent installations of this equipment. Detroit Stoker Co.

7 **Protection for Boiler Settings**—Bulletin B-341 explains how Bernitz air-cooled super blocks prolong the life of boiler settings, do away with furnace operating troubles brought about by clinker adhesion and slag erosion. Contains thermal conductivity of refractory tables, installation photos and other useful data. Bernitz Furnace Appliance Co.

8 **Wide Range Oil Burning**—Peabody Engineering Corp., has issued a new bulletin, No. 109, describing the Peabody CD (Constant Differential) wide range oil burning system. It explains how the system achieves efficient combustion over a range in capacity as great as 50 to 1, controlling any number of Peabody Burners throughout all variations in capacity.

ELECTRICAL

9 **Infrared Dryer**—Folder tells about operation, applications and sizes of Doyle open-glow infrared dryer. Originally used to dry ink in printing plants, now helps speed production of many products. J. E. Doyle Co.

10 **Motor Reconversion Check List**—New 4 pg. folder contains helpful checklist of things to do in finding out if your motors are okay as is; need repairs or replacement; need re-application. Shows you how to make detailed inspection and contains other useful motor hints. Allis-Chalmers Mfg. Co.

11 **Synchronous Generators**—Electric Machinery Mfg. Co. 4-pg. folder No. 177 describes 3.75- to 4.38-kva generators and publication No. 179 discusses 250- to 5000-kva generators.

12 **Fluorescent Lighting**—Handbook number one in a series of know-how lighting booklets deals with the Fluorescent lamp—what it is and how it operates. Contains many helpful diagrams and equipment photos. Westinghouse Electric Corp.

13 **Practical Instruction In Arc Welding**—"Building Your Career in Arc Welding" is a 12-pg. booklet describing the 5 day course offered by Lincoln to provide a sound foundation for new-comers in the fields of welding design and application. Course covers joint design, weldable materials, methods and tools, other basic topics. Lincoln Electric Co.

14 **Prelubricated Ball Bearing Motors**—Bulletin B-3554 and descriptive bulletins 3100-CSP and 3100-1 cover prelubricated ball bearings (for squirrel cage motors of 15 hp and under) that are said to eliminate lubrication for 5 years or more. Westinghouse Electric Corp.

15 **Lightning Arresters**—General Electric Co. 4-pg. bulletin No. GEA-4437 contains complete information on dry nitrogen-filled pellet arresters for protection of apparatus on distribution circuits 15,000 v and below.

16 **X-Ray Diffraction Data**—New 16-pg. illustrated booklet that covers principles and applications of X-ray diffraction has been issued by North American Philips Co. It explains: 1. How X-rays are diffracted. 2. Technique of powder identification. 3. How various types of film-type equipment work. 4. Advantages of the new Geiger-counter X-ray Spectrometer. 5. Low-angle scattering. 6. Particle size and orientation of matter. 7. Alloy formation. 8. Organic compounds. 9. Catalysts. 10. Studies of mineral substances. 11. High polymer work. 12. Petroleum products and 13. Heat exchanger problems.

FANS, PUMPS, COMPRESSORS

17 **Packless Self-Priming Pump**—Bulletin No. 51 describes a radically new approach to an old pumping problem in the form of an improved LaBour Type G pump. This vertical type unit is packingless and self-priming; a hydrobalance pump with a hydrobalance seal. The LaBour Co., Inc.

18 **Gas-Engine-Driven Compressor**—Clark Bros. Co. Sheet presents the Clark BA 2-cycle compressor. Construction features and advantages of this new compressor are included. The BA compressor is available in three sizes.

19 **Hydraulic Handbook**—60-pg. Aldrich Bulletin 50 contains authoritative hydraulic information and tables under heading: Water head equivalents, Pump plunger loads, Pressure equivalents Capacity of shafts, Pump discharge diagrams, Friction losses in fittings and pipes, Capacities of Pumps and Cylinders, Pipe data, etc. The Aldrich Pump Co.

20 **Compressors**—Worthington Pump & Machinery Corp. Bulletins No. H-850-B-65A-445MP, C-1100-B21, C-100-B22, C-1100-B23 and C-1100-B27 discuss Worthington compressors and evaporative coolers.

21 **Compact Turbo Pump**—New Bulletin pictures and describes the Type CG Coffin turbo pump. This pump incorporates all of the operating mechanism; differential control valve, constant pressure regulator, and overspeed trip governor, into an integral, compact machine. Bulletin has sectional views; gives range standard for pumping and steam conditions. The J. S. Coffin, Jr., Co.

22 **Screw Pump Data**—Absence of pulsation and vibration, low maintenance, and other advantages of Sier-Bath screw pumps are discussed in new bulletin. These units were widely used for fuel oil service, sprinklers, handling of heavy viscose materials. Bulletin has pump recommendation charts and other useful engineering data. Sier-Bath Gear Co., Inc.

23 **Compressed Air Handbook**—New 24-pg. two-color booklet entitled, "A Little Air Power Will Do Many a Big Job" contains useful handbook data. Nearly 70 photographs shows how to use compressed air for starting engines, spraying paint or insulation, metallizing, driving pumps and doing many other jobs around the plant. Ingersoll-Rand Co.

INSTRUMENTS AND CONTROLS

24 **Temperature Regulated Steam Pressure Control**—How automatic variations of boiler pressure are synchronized with temperatures by the Temprestat is described in new 4-pg. bulletin. This control is said to assure more uniform heating at low cost in factories office building schools and other steam heated plants. George Roudanez.

25 **Controller Instruction Manual**—Comprehensive file size Leslie Instruction Manual for Operating Engineers gives operating and maintenance data on Leslie reducing valves, regulators, steam whistles. Leslie Co.

26 **Adjustable Water Gages**—New 8-pg. folder describes Ernst split-gland adjustable water gages, clear-through vision glass inserts and other boiler fittings. Ernst Water Column & Gage Co.

27 **"Pressure Safety Appliances"**—Bulletin 502-A is a condensed catalog of Lonergan safety valves, relief valves, pressure gauges, and specialties. Lists essential specifications in tabular form. Illustrates principal design types. Helpful information given to facilitate selection. J. E. Lonergan Co.

28 **Measuring Large Flows of Liquids**—Bulletin 82-A shows how the new Fischer & Porter Rotasleeve utilizes all the basic advantages of the area-type flow meter for the measurement of large flows of liquids and gases. A further development of the rotameter principle, this new instrument is said to give high accuracy, straight line calibration, wide flow range, low pressure loss and instantaneous response to flow changes. The Rotasleeve is a tapered metal sleeve which fits into standard pipe tees from sizes 3-in. and up. Flows as large as 14,000 GPM of liquid and 16,000 CFM of gas can be handled.

29 **Vibrating-Reed Frequency Meters**—Bulletin 1770—16-pg. illustrated with photographs and diagrams—describes James G. Biddle Co.'s line of Frequency Meters—switchboard, portable, and miniature types; also a variety of special models. Ranges from as low as 15 up to 400 cps are regularly supplied; higher ranges on special order. Bulletin gives explanation of the resonant reed principle and vibrating-reed characteristics, as well as how to read the scale.

30 **Pneumatic Transmission in Meters**—A new 28-pg. Data Book No. 1000, entitled "Pneumatic Transmission" has just been issued by the Republic Flow Meters Co. Contains a well illustrated presentation of the principle of pneumatic force-balance and its use in industrial measuring instruments. The construction and operation of various types of pneumatic transmitters for the measurement of flow, pressure, level and density are fully described.

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NOVEMBER, 1945

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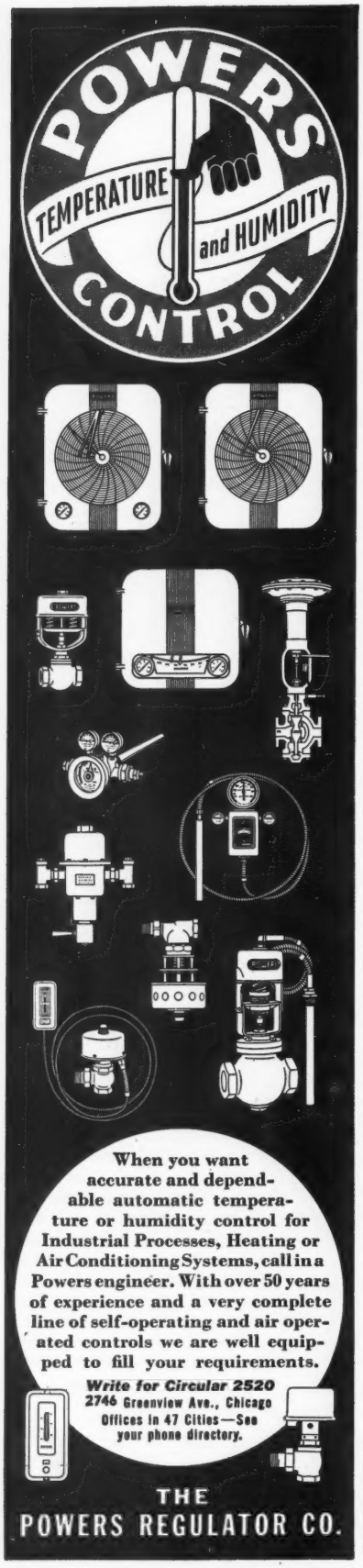
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31 **Open Channel Meters**—Bailey Meter Co. has published Bulletin No. 62 featuring Bailey Open Channel Meters for sewage industrial wastes, sludge, and irrigation water. Meters described are of both the direct mechanical and the electronic telemeter type. A wide selection of registers having various combinations of indicating, recording and integrating features is illustrated.

MAINTENANCE MATERIALS

32 **Maintenance of Fire Extinguishers**—New 12-pg. book "Inspection and Maintenance of First Aid Fire Extinguishers" answers such questions as: What kind of extinguishers to use for different fires, Location of extinguishers, How many, Marking locations, Setting up a maintenance system for various types of extinguishers. A valuable reference book. Walter Kidde & Co.

33 **Non-Slip Safety Flooring**—Physical properties and advantages of Goodyear Griptred are described in attractive new 12-pg. bulletin. Abrasion resistance and non-slip quality makes it suited to factory walkways and stairs, engine rooms, dairies, etc. Goodyear Tire & Rubber Co.

34 **Mechanical Packing Handbook**—New 76-pg. handbook describes varied types of Chesterton mechanical packings for reciprocating rods, rotary or centrifugal rods, hot and cold water, hot oils, solvents, etc. Contains conversion tables for cutting ring packings and other useful engineering data. A. W. Chesterton Co.

35 **Centralized Machinery Lubrication**—Advantages of the centralized lubricating system when installing machine equipment are pointed out in 4-pg. folder, "When You Reconvert," issued by The Farval Corp., Cleveland, O. Shows how the Farval System operates, with examples of specific results attained through its use.

36 **Portable Vacuum Cleaners**—Exidust portable vacuum cleaners suited to the needs of almost every type of industrial plant, public or commercial building, are described in a new 10-pg. bulletin issued by the Allen Billmyre Company. Dimensions, capacity, power, performance, and weights are given for all models and sizes.

37 **Light-reflecting Concrete Floors**—"Light from Floors," a 24-pg. book issued by the Universal Atlas Cement Co. It deals with peace-time possibilities of white-cement both for new floors and the retopping of old floors in factories, schools, offices, hospitals, stairwells, and basements.

MECHANICAL TRANSMISSION

38 **Self-Lubricating Bearings**—New file folder tells about temperature limits, chemical resistance, compressive strength and other characteristics of Morganite self-lubricating bearings. Applications include liquid and gas pumps, hot water circulators, clutches, fans and blowers. Morganite Brush Co.

39 **Midget Clutch**—Bulletin 108 tells about the Mercury midget clutch—an automatic mercury actuated clutch developed to overcome the problems of applying ¼ hp. motors to the drives of such equipment as domestic washing machines, refrigerators, air conditioners. Bulletin gives clutch dimension and performance data. Mercury Clutch Corp.

40 **Spiral-Bevel Speed Reducers**—Bulletin 200 gives design features, hints on selecting proper units, table of load characteristics, horsepower ratings and other helpful handbook data on Philadelphia spiral-bevel speed reducers. Also pictures typical installations. Philadelphia Gear Works, Inc.

41 **Coupling Data Book**—How the Waldron gear type coupling cures jitterbug shafts is explained in Catalog No. 56. Also gives rating tables, operating hints and other useful data on couplings. John Waldron Corp.

42 **Useful Shaft Data**—New 16-pg. book with handy data and short cuts should be a great time saver for any one whose work involves determination of required shaft sizes. It includes tables, curves and formulas for computing torque, deflection angle of thrust, bending moment, and other factors in solid, hollow, keywayed and stepped shafts. Worm Gear Div. of the De Laval Steam Turbine Co.

43 **Handbook On Belting Problems**—A Tannate Handbook has been put out to help with belting problems. It gives information on short center, modern group and individual drives; tells how to lace belts or make them endless; offers suggestions for improving belt drives, aligning pulleys and belt care. Contains many tables and diagrams. J. E. Rhoads & Sons.

PIPING, VALVES, FITTINGS

44 **Condenser Tube Manual**—Bridgeport's 112-pg. Condenser Tube Manual contains practical, up-to-date information about tube alloys; specifications; corrosion research data; methods of installing; suggestions for increasing tube life. There are 39 illustrations, 29 diagrams and 23 tables to help present this important information. Bridgeport Brass Co.

45 **Steam Traps**—Yarnall-Waring Co. Bulletin No. T-1739 covers features, construction details, applications, installations, operating suggestions, capacities, weights, dimensions and prices of Yarway steam traps.

46 **Valves**—Wm. Powell Co. 20-pg. booklet provides helpful information on the selection, design, construction, application and care of valves.

47 **Weldolet Branch Pipe Outlet Fittings Handbook**—New 16-pg. catalog contains application information, structural data, installation procedure, specifications, and list prices of Bonney WeldOlet fittings for making full-pipe-strength, permanent, leakproof branch pipe outlets. Also describes WeldOlet Drain-Out fittings and the complete line of Bonney flanges. This handbook can help you make branch pipe outlet jobs easier, faster, safer. Bonney Forge & Tool Works, Forged Fittings Div.

48 **Facts You Should Know About Silbraz Joints**—The Silbraz joint—the modern threadless connection that bonds I.P.S. copper tubing and brass pipe into a single "one-piece" pipe line—is described in Airco's new 16-pg. 2-color booklet: "How to Cash in on the Silver Ring." Shows how Silbraz joints are made from patented bronze pipe fittings, valves and flanges—containing a factory inserted ring of silver brazing alloy in each port opening. Air Reduction Sales Co.

WATER TREATMENT

49 **Water Testing Equipment**—Attractive 28-pg. booklet reviews the how and why of water analyses; describes modern equipment for making hardness, alkalinity, sulfite and other tests. Many illustrations. The Bird-Archer Co.

50 **All-Purpose Water Filter**—Bulletin 675 tells about the new Adams TF-1 model twin filter for a wide variety of applications wherever water must be "polished" for drinking purposes, bakery supply, restaurant and hotel service, laundry and paper mill shower use as well as general industrial water systems. This is a self-contained unit, easy to install and self-cleaning in operation. R. P. Adams Co.

51 **Mechanically Cleaned Water Screens**—Rex mechanically cleaned bar screens are described in a new 8-pg. bulletin No. 479. An explanation of what the machine is and how it handles trade wastes, operates in sewage disposal and water treatment plants is combined with typical job photographs and application drawings. Data tables and specifications are also included. Chain Belt Co.

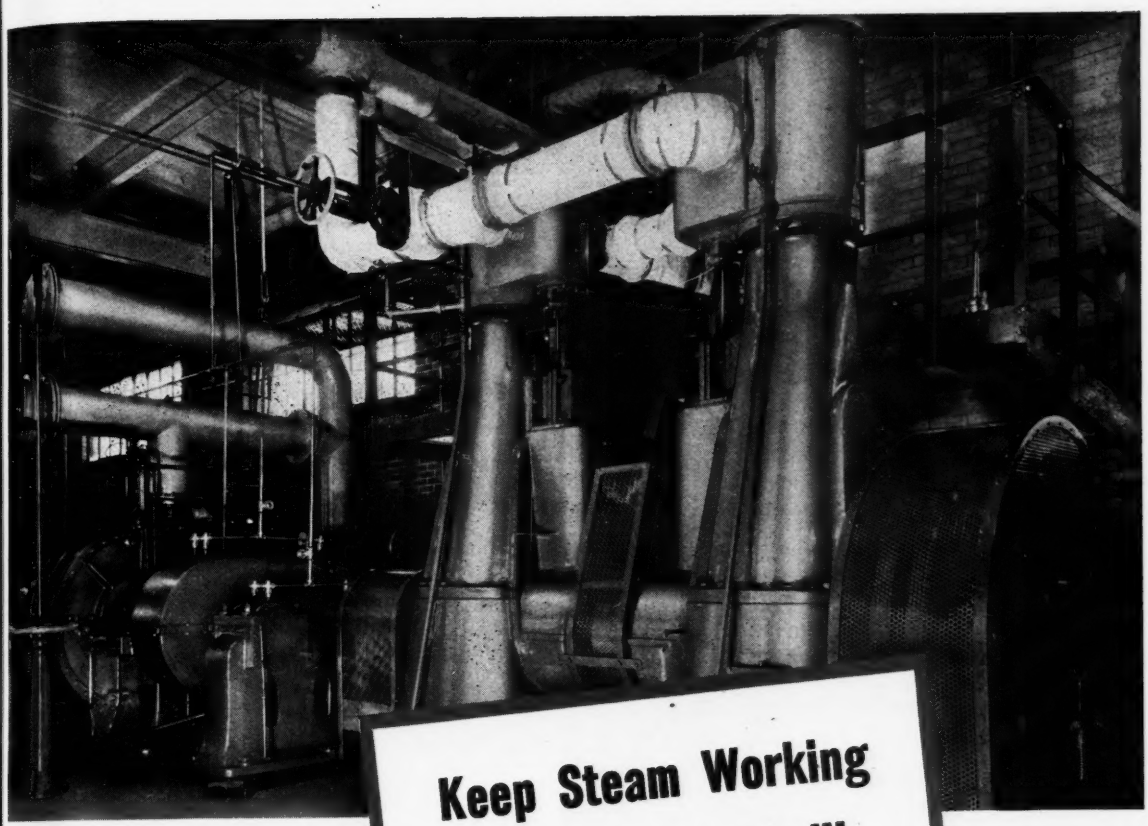
52 **Modern pH and Chlorine Control**—A completely revised edition of the Taylor combination handbook and catalog contains both simple and technical explanations of the meaning of pH control; specific discussions of the application of various control methods to 35 industries, such as pH, ortho and poly phosphates, nitrates and silica in boiler water and ammonia in steam condensate; the precautions to be observed in making determinations; and descriptions of all Taylor outfits. W. A. Taylor & Co.

MISCELLANEOUS

53 **Mineral Wool Insulations**—Baldwin-Hill Co. has issued a new 28-pg. Industrial Catalog describing in detail the various high and low temperature mineral wool insulations made by this firm. Book is fully illustrated and complete with application specifications, conductivity curves and engineering data.

54 **Steel Plate Fabrication**—New 4-pg. bulletin describes dust collectors, coal and ash hoppers, smoke stacks, breechings, screw conveyors, platforms, stairways and other steel plate jobs turned out by Nazareth Steel Fabricators, Inc.

55 **Tank Construction Handbook**—New Downington Catalog No. 102 illustrates some tanks, turbine scroll cases, heat exchangers and other fabrications by Downington. Also contains facts about ASME code for unfired pressure vessels, capacity table and other handbook information. Downington Iron Works.



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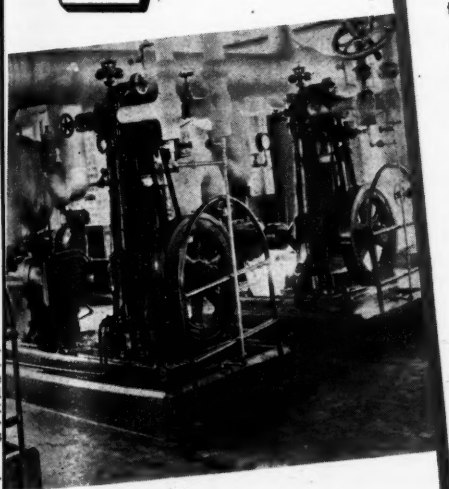
Power wasted by passing live steam through a pressure reducer makes your heating cost higher than it should be. This lost power can be recovered and a saving effected by first using the steam to drive a Troy-Engberg Steam Engine.

The energy thus converted can be utilized to drive a generator, stoker, blower, compressor or other equipment. After being used in this manner, the steam at proper pressure goes on to do its principal job of heating.

Savings in power costs—either direct or through fuel economies—quickly repay your entire investment sometimes in as little as one year.

If you use low-pressure steam in your plant for heating or processing, investigate the possibility of using Troy-Engberg Steam Engines to provide By-Product Power.



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Every community and all industry should check their fire fighting equipment, and the most important item of all is the Fire Hose.

Quaker, during the war, manufactured millions of feet of Quality Fire Hose. This dependable Quality Fire Hose is now available for all: city fire departments, industrial

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Whether you need 50 feet or 50,000 feet Quaker is ready to serve you promptly.

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POWER PLANT Construction News

Ala., Sylacauga—Water Department has plans under way for new filtration plant and pumping station for raw water supply for municipal water system. Cost about $170,000. J. W. Goodwin Engineering Co., Martin Bldg., Birmingham, Ala., is consulting engineer.

Ariz., Phoenix—Crystal Ice & Cold Storage Co., 246 South 2nd Ave., has plans under way for new multi-story cold storage and refrigerating plant, reported to cost over $250,000 with equipment. F. E. Wille is general manager.

Calif., El Centro—Imperial Irrigation District has plans for new steam-electric generating station on site being purchased from city, and construction is scheduled to begin soon. Plant will be equipped for large output. No official estimate of cost announced. District is planning bond issue of $6,200,000 for expansion and improvements, including project noted, transmission and distribution lines, and other work.

Calif., Imperial—Holly Sugar Corp., Colorado Springs, Colo., plans power plant at proposed new beet sugar mill near Imperial, where tract of land has been acquired. Project will comprise several one and multi-story processing and production buildings, equipped for slicing capacity of about 2400 tons per day. Electric power equipment will be installed. Cost reported over $1,300,000.

Calif., Los Angeles—Sardamack Fisheries, 221 Anapaca St., Wilmington, Los Angeles, plans installation of electric power equipment in new one-story fish-processing and packing plant, 120 x 264 ft. Several other buildings will be erected for storage, distribution and miscellaneous service. A boiler house is planned. Entire project will cost over $450,000. James R. Friend, 128 West 8th St., San Pedro, Los Angeles, is architect. Erection will begin soon.

Conn., Norwalk—Norwalk Tire & Rubber Co., Wimmipauk section, tires and tubes, mechanical rubber goods, etc., has plans for new boiler house at plant. Cost reported over $75,000, with equipment. Fletcher-Thompson, Inc., 211 State St., Bridgeport, Conn., is architect and engineer.

Ill., Des Plaines—General Molded Products Co., 1300 Oakwood St., plastic products, plans installation of electric power equipment in new one-story addition, 140 x 160 ft. Proposed to begin erection soon. Holsman, Holsman & Klekamp, 140 South Dearborn St., Chicago, Ill., are architects.

Ill., Savanna—City Council has surveys and estimates of cost in progress for a proposed municipal power plant. Stanley Engineering Co., Muscatine, Iowa, is consulting engineer.

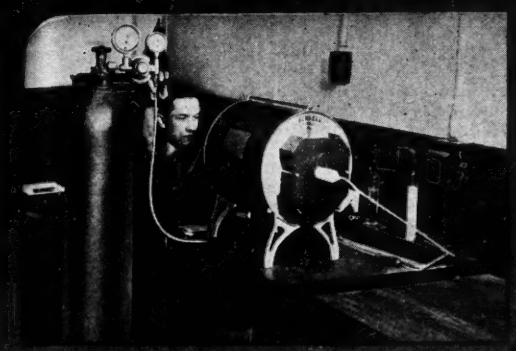
Ind., Columbia City—City Council has rejected all bids recently received for addition to municipal steam-electric generating station, and proposes to ask new bids next spring. Capacity will be increased. Laramore & Douglass, Inc., 327 South LaSalle St., Ill., is consulting engineer.

Ind., Tipton—Light and Water Department has plans in progress for new municipal power plant, to occupy part of 6-acre tract of land recently acquired. Installation will include a Diesel engine-generator unit and auxiliary equipment. Cost reported about $200,000. Worth N. Yoder is engineer and manager.

Ky., Lexington—Kentucky Utilities Co., 159 West Main St., Lexington, has plans maturing for new steam-electric generating plant, to be known as Riverside Station, on site of Kentucky River. Installation will include a 25,000-kw turbine-generator, high-pressure coal-fired boilers and auxiliary equipment. New transmission lines will be built for connection with present high-tension system. Entire project will cost about $4,000,000 and is scheduled for completion early in 1947.

Mass., Framingham—Worcester Gas Light Co., 240 Main St., Worcester, Mass., has plans for new boiler plant at Framingham, for service in connection with local artificial gas works and system. No estimate of cost announced.

Mass., Springfield—Smith & Wesson, 55 Stockbridge St., revolvers and other small firearms, plan installation of electric power equipment in three new one-story plant



Test for determining the amount of carbon in steel.

Determining the amount of essential elements from steel samples.

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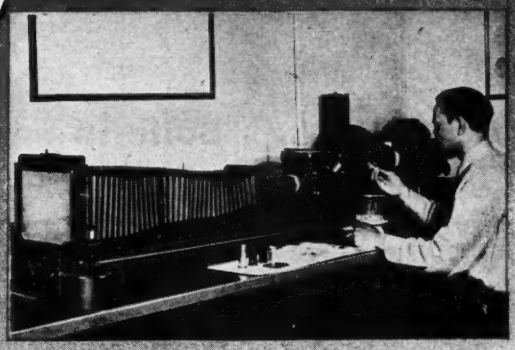
Rockwell testing machine for determining the hardness of metals.



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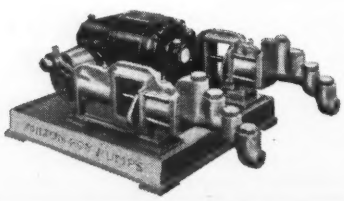
- Describes simple, complete "Packaged" units to meet above requirements . . . a brand new Milton Roy development.
- Contains selection tables from which to choose units of proper capacity for single or multiple boilers operating over a wide range of pressures and make up water requirements.
- This bulletin is "must" reading for every power plant operating engineer. Send for it.



MILTON Roy PUMPS
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additions, 80 x 150 ft, 60 x 100 ft, and 60 x 60 ft, reported to cost close to $100,000, with machinery. Work is scheduled to begin soon. Leon J. Gour, 49 Genesee St., Springfield is architect.

Mich., Crystal Falls—Light and Water Department, City Hall, has plans under way for new municipal hydroelectric power plant, to supplement present station of such type. Surveys and estimates of cost are being made. Holland, Ackerman & Holland, Ann Arbor, Mich., are consulting engineers.

Mont., Helena—Bureau of Reclamation, Denver, Colo., has preliminary plans under way for proposed Canyon-Ferry hydroelectric power project on Missouri River, Montana, consisting of a power dam about 180 ft high and crest of 800 ft. Generating station will be equipped for initial rating of 35,000-kw. Entire project estimated to cost about $11,000,000, including transmission lines.

Nev., Reno—Board of Trustees, University of Nevada, Reno, has plans in progress for expansion and modernization in boiler house, used for central-heating service at institution, including installation of additional boilers and auxiliary equipment. Cost reported over $300,000. Edward S. Parsons, 800 Arlington Ave., Reno, is architect.

N. J., New Brunswick—Ford Motor Co., Dearborn, Mich., plans installation of electric power equipment in proposed new assembling plant for Lincoln and Mercury automobiles in Raritan Township, near New Brunswick, where tract of over 75 acres of land has been secured. Main building will comprise about 500,000 sq ft floor space. A boiler plant will be built. Entire project is reported to cost about $3,000,000. Proposed to begin erection early next spring.

Ohio, Camden—Board of Public Affairs has surveys and estimates of cost under way for a proposed municipal power plant. It is understood that recommendations will be for a Diesel engine-generator installation, with auxiliary equipment.

Ore., Klamath Falls—Coca Cola Bottling Co., 665 Spring St., plans installation of electric power equipment in new one-story bottling plant at Spring and Main Sts., about 95 x 125 ft. A boiler house will be built for central-heating service. Entire project will cost over $100,000 and is scheduled to be carried out early in 1946. Howard Perrin, 1121 Main St., Klamath Falls, is architect.

Tenn., Chattanooga—H. L. Judd Co., East Chattanooga, metal products for domestic service, wire goods, stampings, etc., plans installation of electric power equipment in new one-story plant, 80 x 500 ft, on local site, with several auxiliary units. A boiler house will be built. Cost reported close to $300,000. Work will begin soon. B. F. Hunt & Associates, James Bldg., Chattanooga, are architects. Main offices are at Wallingford, Conn.

Texas, Tyler—Bryant Heater Co., 17825 St. Clair Ave., Cleveland, Ohio, gas furnaces, unit heaters, etc., plans installation of electric power equipment in new branch plant at Tyler, where tract of land has been secured, comprising several one-story buildings. Cost reported over $350,000, with machinery. Thomas, Jameson & Merrill, Construction Bldg., Dallas, Texas, are architects.

W. Va., Charleston—Westvaco Chlorine Products Corp., Charleston, liquid chlorine, etc., plans installation of electric power equipment in new addition to plant. Entire project will cost close to $400,000. Work is scheduled to begin soon. Main offices are at 405 Lexington Ave., New York, N. Y.

Wis., Marshfield—Water and Light Commission, City Hall, will receive bids until December 3, for new boiler unit, firing equipment and accessory apparatus for installation in steam division of municipal plant, where expansion will be carried out. Helmick, Edeskuty & Lutz, Essex Bldg., Minneapolis, Minn., are consulting engineers.

Wis., Richland Center—Municipal Utilities Department, North Central Ave., has plans maturing for extensions in steam department at municipal power plant, including installation of new boiler and accessory equipment. Cost estimated close to $165,000. Ralph D. Thomas & Associates, Inc., 1200 Second Ave., South, Minneapolis, Minn., is consulting engineer.

CORRECTION NOTE

In Power Plant Construction News items published on page 204 of the October, '45, issue, the last lines of two items were transposed while making last minute corrections. The last line of the item from Tenn., Memphis, should read "approximately $500,000," and the last line of the item from Va., Richmond, should read "ported to cost about $1,500,000."

WHEN YOU BUY A RELIEF OR SAFETY VALVE---

You pay a sizable sum for ANY relief or safety valve. So when you buy one, specify FARRIS—and get the *added* protection, the *maintenance-free* performance, and the *dependability* for which the FARRIS valve is noted.

HYDRAULIC RELIEF VALVE—Type 1425. Heavy duty bronze. Pressures to 1500 lb. Sizes ½" to 2".

STANDARD RELIEF VALVE—Type 1400. Liquid service to 300 lb. Both piping connections in body. Sizes ½" to 2½".

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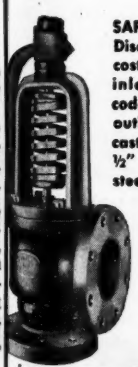
Foremost, are the *improved engineering features* on FARRIS relief and safety valves. Such as "high-lift"—for accurate non-shock operation and minimum loss of pressure from relief action. And "precision alignment" of spring, stem, disc, guide, and seat—for precision operation and trouble-free performance. And sturdy construction—for long life. And fewer valve parts—for reduced risk of failure.

FARRIS relief and safety valves are designed by skilled valve engineers of long experience. All materials are rigidly specified . . . to secure the superior strength and durability which modern metallurgical science and thousands of valve installations have proven *safest*. Improved foundry methods and *precision machining* of all finished surfaces in FARRIS valves contribute to their precision operation. Skilled valve mechanics only are employed for assembly and adjustments. Rigid final inspection and rigorous testing assure *dependable* operation of FARRIS valves.



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HERE'S an efficient and practical way to control valve operations from any convenient point in your plant . . . with Hills-McCanna air-actuated valves. This unit combines the proved principle of the Hills-McCanna Diaphragm Valve with Westinghouse Flex-air and/or Controlair Controls and air-operated piston to give you smooth control . . . finger-tip service at all times.

And since this new Hills-McCanna unit . . . like all Hills-McCanna valves . . . *has no packing*, there's no sticking of the stem to interfere with easy, accurate positioning.

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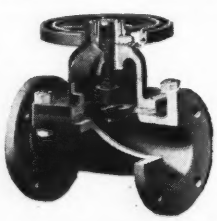

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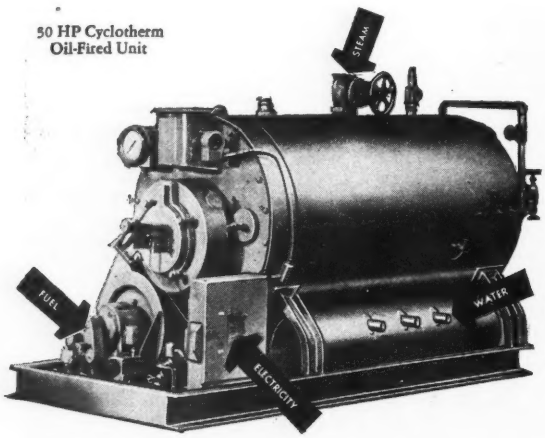
50 HP Cyclotherm Oil-Fired Unit



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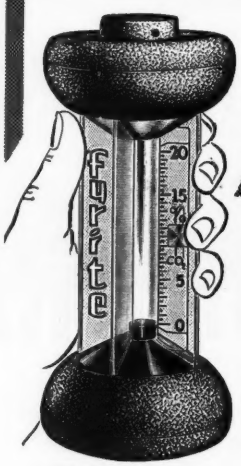

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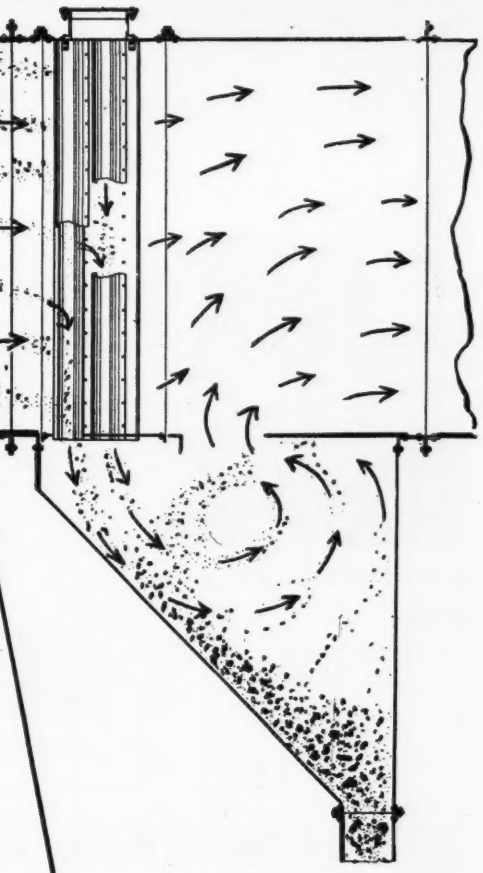

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Traps from 75% to 96% of the cinders in flue gas.
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Hudson Coal Co.
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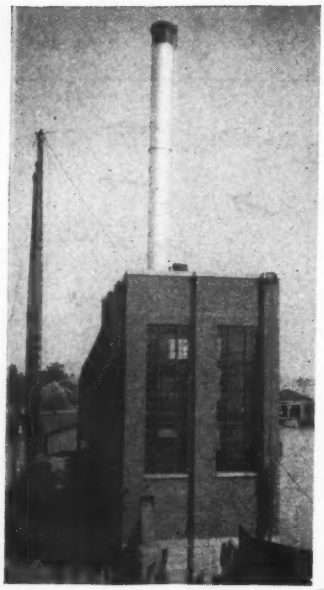

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Holds Down Maintenance at
DUNN SULPHITE PAPER CO.

Taking a tip from hundreds of other industrial plants and central stations, the Dunn Sulphite Paper Co. at Port Huron, Mich., picked Connery Construction for the breeching and flues of its new and highly efficient power station. For complete description of this plant see January, 1945, Power Plant Engineering.

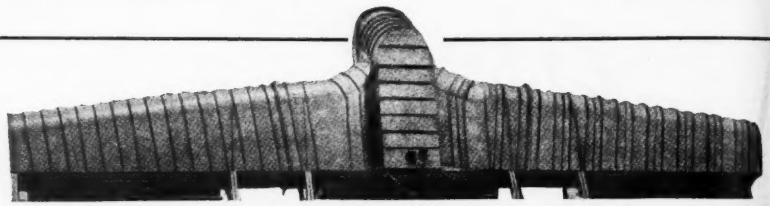
Here, Connery Construction will eliminate the headaches that result from buckling, warping, loose joints. It will assure maximum contraction and expansion—step up efficiency of draft —prevent internal corrosion—help hold down plant maintenance expense.

Write for 36-page Connery Handbook. It shows how Connery's Expansion Stiffener makes breechings, flues and uptakes serve better and last longer; contains specification data; picture applications in different industries.

CONNERY CONSTRUCTION CO.
Second and Luzerne Sts., Philadelphia, Pa.

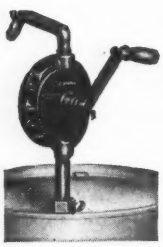
Get a CONNERY BID on:

STACKS
BREECHINGS
UPTAKES
HOPPERS
AIR DUCTS



*Connery Construction is electrically welded, with "V" stiffeners pressed into the metal; permits uniform expansion and contraction; won't warp or buckle.

BLACKMER ROTARY PUMPS *are* COST CUTTERS



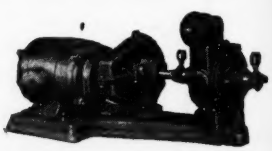
HAND PUMPS and POWER PUMPS are SELF-ADJUSTING FOR WEAR

The "Bucket Design" swinging vanes automatically compensate for wear. When the "buckets" finally wear out, a simple replacement job restores the pump to normal capacity.

THIS MEANS LOWER PUMPING COSTS

Write for Bulletin No. 307 — Facts About Rotary Pumps

BLACKMER PUMP COMPANY
2010 Century Avenue **Grand Rapids 9, Michigan**



POWER PUMPS • HAND PUMPS • EZY-KLEEN STRAINERS

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Manzel Force Feed Lubricators deliver their oil directly to cylinders and bearings with clock-like precision—never too much nor too little. There is no better insurance against wear.

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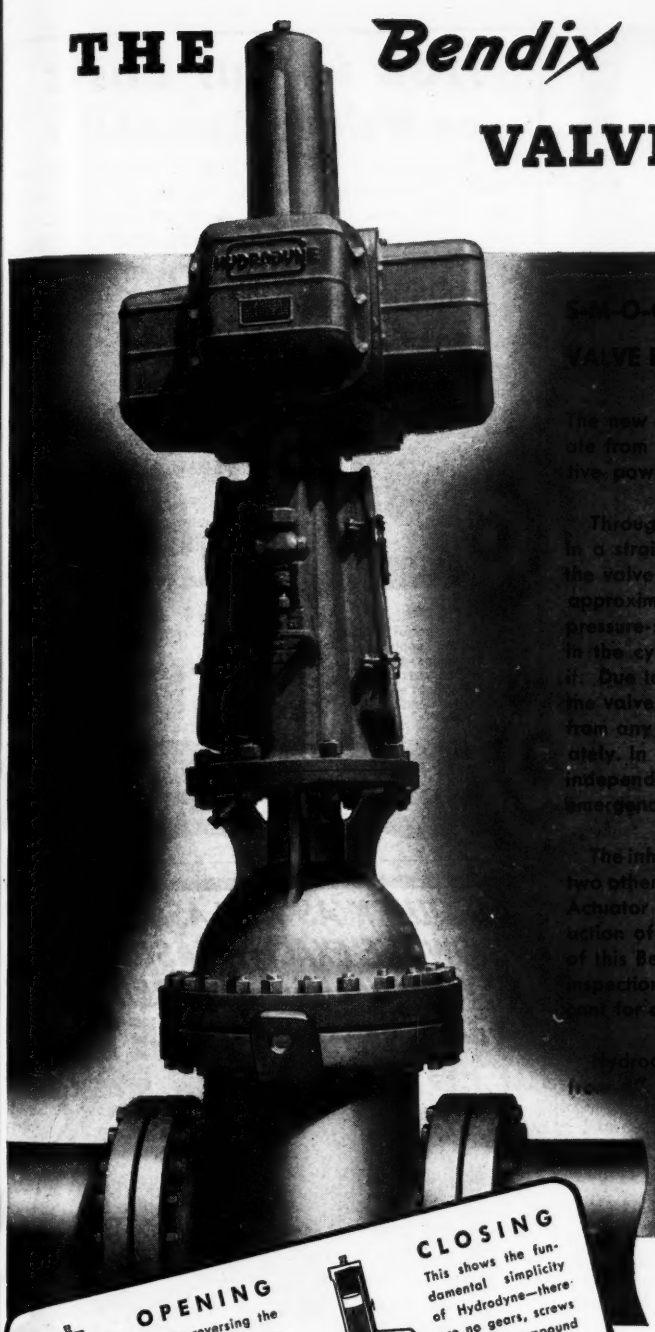
Livingston, N. J. Livingston 6-1400

THE *Bendix* HYDRODYNE VALVE ACTUATOR



S-M-O-O-T-H HYDRAULIC POWER ELIMINATES VALVE BOUNCE AND HAMMER-BLOW ACTION

The new Bendix Hydraulic Valve Actuators, which operate from electrical power sources, provide smooth, positive power for opening and closing valves.

Through a simple hydraulic system, force is produced in a straight line through a cylinder to open and close the valve. As the valve seats, this pressure builds up to approximately 10 times the operating pressure, literally pressure-sealing the valve. The pressure is then locked in the cylinder and only the reverse action will unlock it. Due to this positive seating action it is impossible for the valve to "bounce" or leak. Should the pressure drop from any cause it is automatically re-established immediately. In addition, the unit is provided with a completely independent hydraulic system, using a hand pump, for emergency operation.

The inherent advantages of hydraulic operation provide two other outstanding characteristics: (1) the Hydrodyne Actuator is completely free from the "hammer-blow" action of other actuating devices, and (2) maintenance of this Bendix development has been reduced to routine inspection because the hydraulic oil serves as a lubricant for all moving parts.

Hydrodyne Actuators are available for use on valves [illegible]" to 36" and can be applied to most types of valves. They can be set to actuate at speeds ranging from 12" per second to 6" per minute. Complete auxiliary indicating and regulating equipment [illegible] provided.

OPENING

Merely reversing the motor and pump forces oil into the lower end of the cylinder, opening the valve. The smooth hydraulic power can be reversed instantaneously — there is no hammer-blow action — or it can be arrested at any point for as long as desired.

CLOSING

This shows the fundamental simplicity of Hydrodyne—there are no gears, screws or other compound mechanisms. A small reversible electric motor drives the oil pump, forcing hydraulic fluid into the upper cylinder, closing the valve by straight line action. Bounce and backlash are completely eliminated.

☆ ***COMPLETE DATA ON BENDIX HYDRODYNE ACTUATORS IS INCLUDED IN CATALOG HVA-502 WHICH WE WILL GLADLY SEND TO RECOGNIZED COMPANIES ON REQUEST.***

Pacific Division

PRODUCT OF Bendix AVIATION CORPORATION

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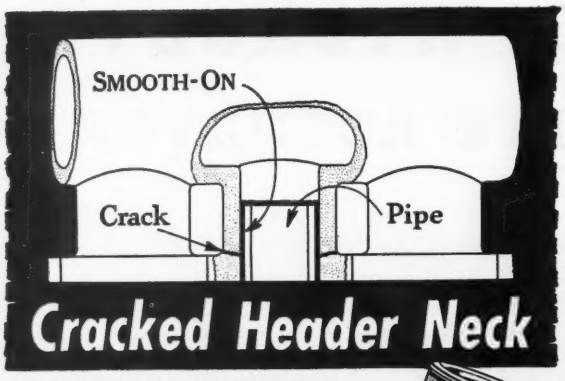

Cracked Header Neck INGENIOUSLY REPAIRED

● At a large power plant in Saskatchewan, Canada, a crack developed in an economizer header neck. A new header section would have taken weeks to get. With Smooth-On No. 1 Iron Repair Cement, a little ingenuity and negligible cost, the economizer was quickly put back in service.

A length of wrought iron pipe was fitted into the header neck, allowing 1/16th inch clearance all around. This space was packed with a soft paste of Smooth-On No. 1 and allowed to harden. Back in service, under 150 lbs. pressure at 220 F., the header remained in use for six years and later saw service in another plant, under lower pressure and temperature for another seven years.

Smooth-On No. 1 has been popular in plants, mills and factories the past 50 years, for stopping leaks, sealing cracks, tightening loose parts. Easy to use, requiring no heat. Makes repairs that last. Costs little. Sold in 1-, 5-, 25- and 100-lb. sizes at supply houses. If yours hasn't it, contact us direct.

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Do it with **SMOOTH-ON**
The Iron Repair Cement of 1000 Uses

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Let Rempe make them. Through correct forming on precision bending machines, welding ells, cuts and line welds are eliminated. Cost of assemblies is greatly reduced and a more sturdy, more practical, and more attractive unit results.

Here is a special welded assembly and supply header made by Rempe.—64 welding ells, 128 cuts and 128 line welds were eliminated by precision bending.

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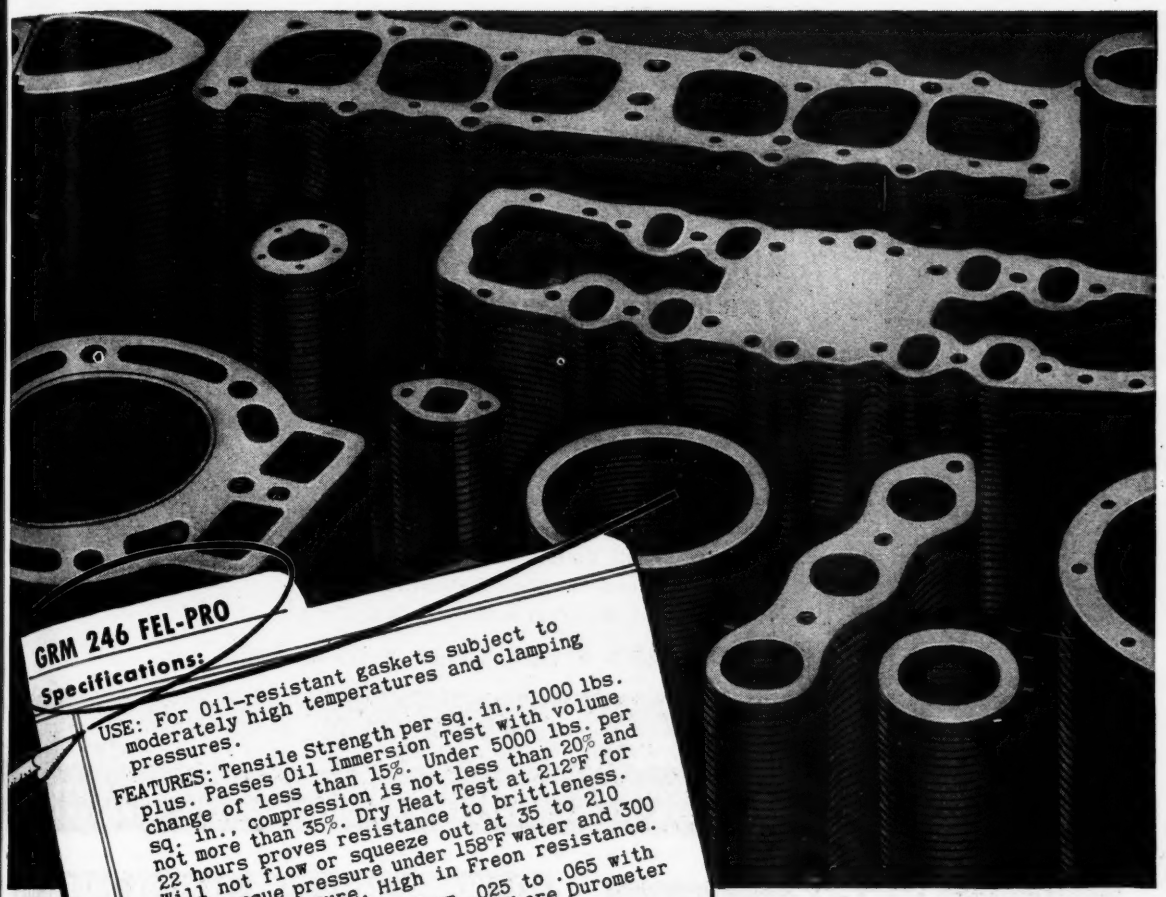
GRM 246 FEL-PRO
Specifications:
USE: For Oil-resistant gaskets subject to moderately high temperatures and clamping pressures.
FEATURES: Tensile Strength per sq. in., 1000 lbs. plus. Passes Oil Immersion Test with volume change of less than 15%. Under 5000 lbs. per sq. in., compression is not less than 20% and not more than 35%. Dry Heat Test at 212°F for 22 hours proves resistance to brittleness. Will not flow or squeeze out at 35 to 210 lbs. torque pressure under 158°F water and 300 lbs. air pressure. High in Freon resistance.
AVAILABLE in thickness from .025 to .065 with hardness equivalent of 85-95 Shore Durometer Type A.

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Advantage One is Fel-Pro's Know-How, resulting from years of experience in providing the answers to difficult gasket problems. Advantage Two is Fel-Pro's production facilities, the specially developed equipment that makes possible ECONOMICAL PRODUCTION to HIGHEST QUALITY STANDARDS.

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Send me, without obligation, FREE PORTFOLIO of SEALING MATERIALS and details on your NO CHARGE CONSULTATION SERVICE.

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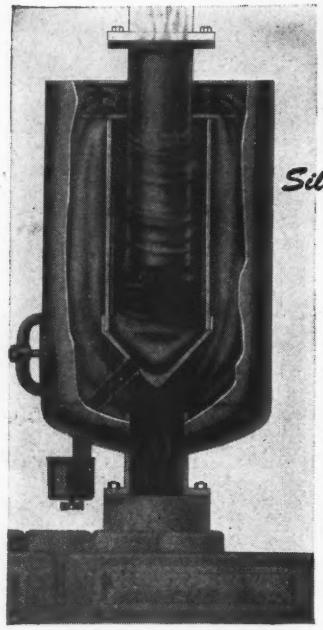
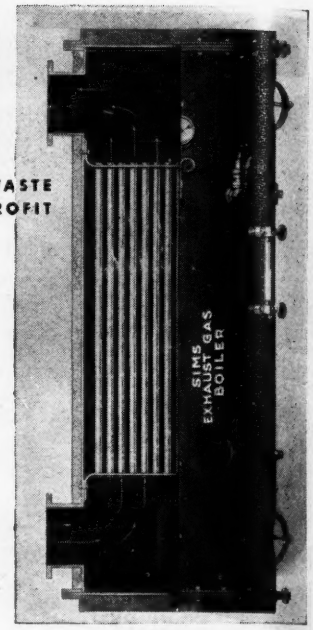


Silence THE EXHAUST

Convert WASTE HEAT TO PROFIT



SIMS Offers Three Services to Your Internal Combustion Engine

● Illustrated here are three important ways to protect and enhance your engine investment. Sims Heat Exchangers are serving on land and sea to keep jacket cooling water at the safe temperature in all types of internal combustion engines. Plan now to utilize exhaust heat through a Sims Boiler. Write for "Heat Recovery" Bulletin describing these two services and for Sims Cyclone type Silencer Bulletin, the latest of Sims Products.

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WITH QUESTIONS AND ANSWERS

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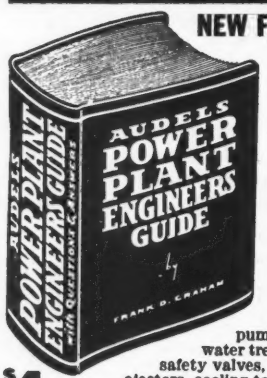

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They cannot be affected by dust, dirt or corrosion; nor are they subject to open arcing, oxidation, pitting or sticking of contacts. They will give better control service and longer control life.

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The Bourdon tube is the actuating element of the control. It is the oldest known, tried and proven element, having been used in gauges for many years.

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The glass face on the cover permits seeing the entire operation of the control in plain view. One can always tell whether the switch circuit is open or closed, a great convenience whenever servicing becomes necessary.

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The outside double adjustment with the calibrated dial and pointers is a convenient feature, making it very easy to set the required operating range, plainly visible on the dial. All guesswork is eliminated.

Mercoid Controls give 100% Mercury Switch Protection

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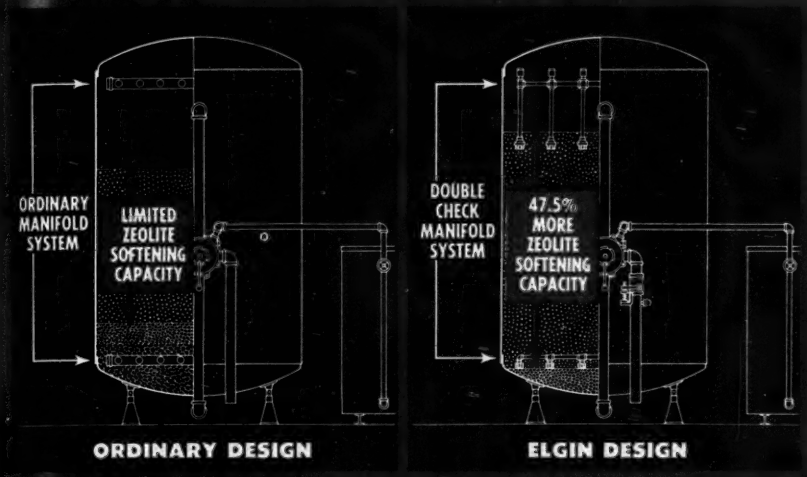
FOR HEATING, AIR CONDITIONING, REFRIGERATION, AND INDUSTRIAL APPLICATIONS
THE MERCOID CORPORATION, 4201 BELMONT AVE. CHICAGO ILL.

ELGIN WATER SOFTENER

gives 12,600 gallons more soft water



HERE is a typical example of Elgin performance. The two water softeners diagrammed above are identical in size (36" x 72"). Each uses synthetic zeolite to soften ten-grain water. In actual performance, the Ordinary Design softens only 26,500 gallons of water per regeneration, while the Elgin Design softens 39,100 gallons of water per regeneration. Think of it—12,600 gallons or 47.5% more soft water with the Elgin!

The reason for this remarkable increase in soft water output is shown in the illustrations above. Note the far greater zeolite content of the Elgin — made possible by an ingenious "Double-Check" manifold system. This design makes the deeper bed possible without loss of zeolite—a loss that the ordinary water softener attempts to avoid during backwashing by using a shallow zeolite bed, as illustrated.

Of course, more zeolite means more soft water output, for it's the zeolite that softens water. But the "Double-Check" manifold system goes beyond that . . . prevents zeolite loss . . . permits zeolite to be washed cleaner . . . prevents packing and channeling of the bed. Thus the brine reaches every granule of zeolite, producing more efficient regeneration with less salt consumption.

INCREASE THE SOFT WATER OUTPUT OF YOUR PRESENT WATER SOFTENER WITH "DOUBLE-CHECK" MANIFOLD SYSTEM

The "Double-Check" manifold system can be quickly installed in water softeners of any make. This change supplemented by remarkable high capacity ELGIN ZEOLITE *when required will greatly increase soft water output and operating efficiency. The cost of such modernization is surprisingly low.*

For facts about the Elgin Water Softener or modernization of your present water softener, write for Bulletin 603.

ELGIN SOFTENER CORPORATION, 136 N. Grove Ave., Elgin, Ill.

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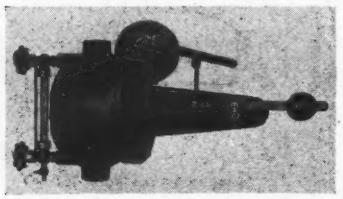
ECONOMICAL
WATER CONDITIONING

WATER CONDITIONING FOR EVERY NEED

DAVIS FLOAT BOXES *for Liquid Level Control of:*

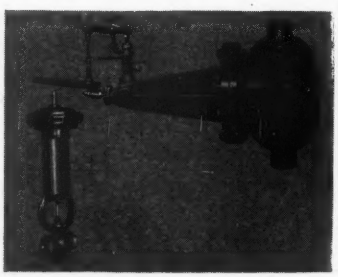
- TANK VALVES
- SIGNAL SWITCHES
- MOTORS
- OTHER EQUIPMENT



Davis No. 164 Float Box with Mercury Tube Switch.

DAVIS Float Boxes are used in connection with closed tanks where fluctuation of the fluid level within the tank is the governing factor in the control of all types of electrical switches, control valves, pilot valves (for operation of diaphragm motor valves), motors and other equipment. Davis fluid control equipment also includes internal float units for direct or pilot operation. Whatever your requirement may be, Davis can supply you with a combination of float box and control valve to make your control accurate, positive, and dependable.

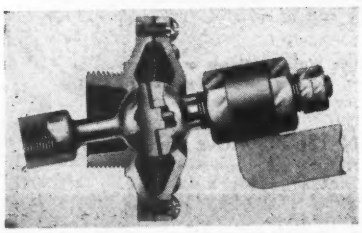
Drop us a card today for detailed information on the Davis line. Ask for Bulletin 101AA. DAVIS REGULATOR COMPANY, 2508 S. WASHTENAW AVE., CHICAGO 8, ILL.



Davis No. 162D Packless Float Box with Pilot Valve and No. 14 Diaphragm Motor Valve.

DAVIS DIA-BALL TRANSMISSION UNIT

A patented, leakproof, corrosion resistant packless assembly eliminating the packing box on Davis Float Boxes and Control Valves.



Especially recommended for vacuum service or for use with volatile and inflammable fluids where a packing box is objectionable because of leakage. For pressure up to 300 lbs. and temperatures up to 450° F.

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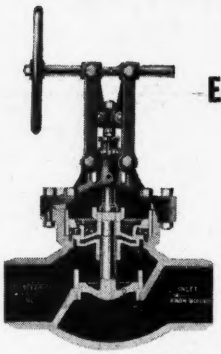

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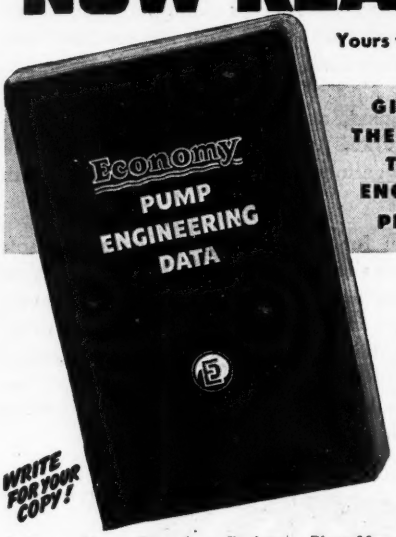

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The pledge of "Satisfaction or No Charge", and the proven quality of Stonhard materials, are the basis for the continued growth of Stonhard Company. Therefore, may we have the privilege of serving you with the best in building maintenance materials?

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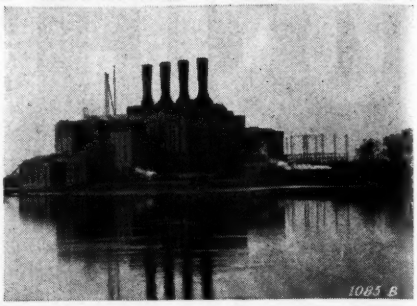

The performance of two large "Pennsylvania" Bradford Breakers at this Station, installed in 1923 and 1926, has again proven the endurance and low cost operation of this type, in service where unfailing dependability is a "MUST."

As a result of this performance, duplicate Bradfords were installed in a later Station of the same system.

There are some 60 of these Central Station Bradford installations in the U. S. A., and more in process.

Installed capacity of "Pennsylvania" Coal Preparation Equipment at home and abroad, now approximates 300,000,000 tons per annum.

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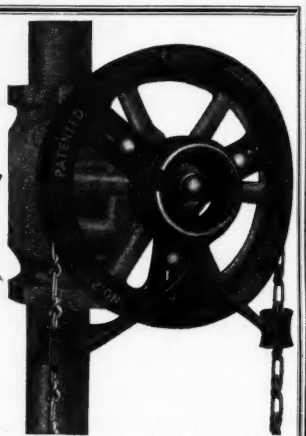
For All "HIGH-UP" VALVES



Every overhead valve in your plant should have the easy, safe, instant control from the floor which Babbitt Sprocket Rims provide. . . . Babbitt Rims are low in cost; quickly attached; they save time, steam and accidents. Install them now. Write for descriptive folder.

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Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

the MARMAN universal does the job!

clamps round and odd shaped ducts of air-borne portable generating plants

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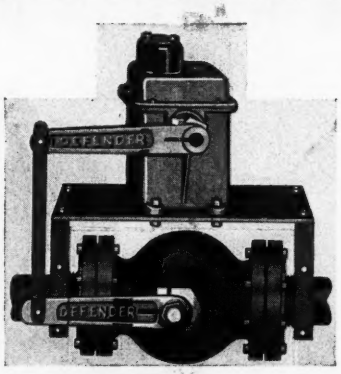

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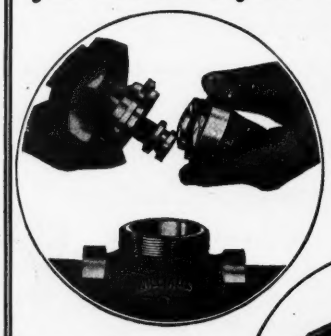

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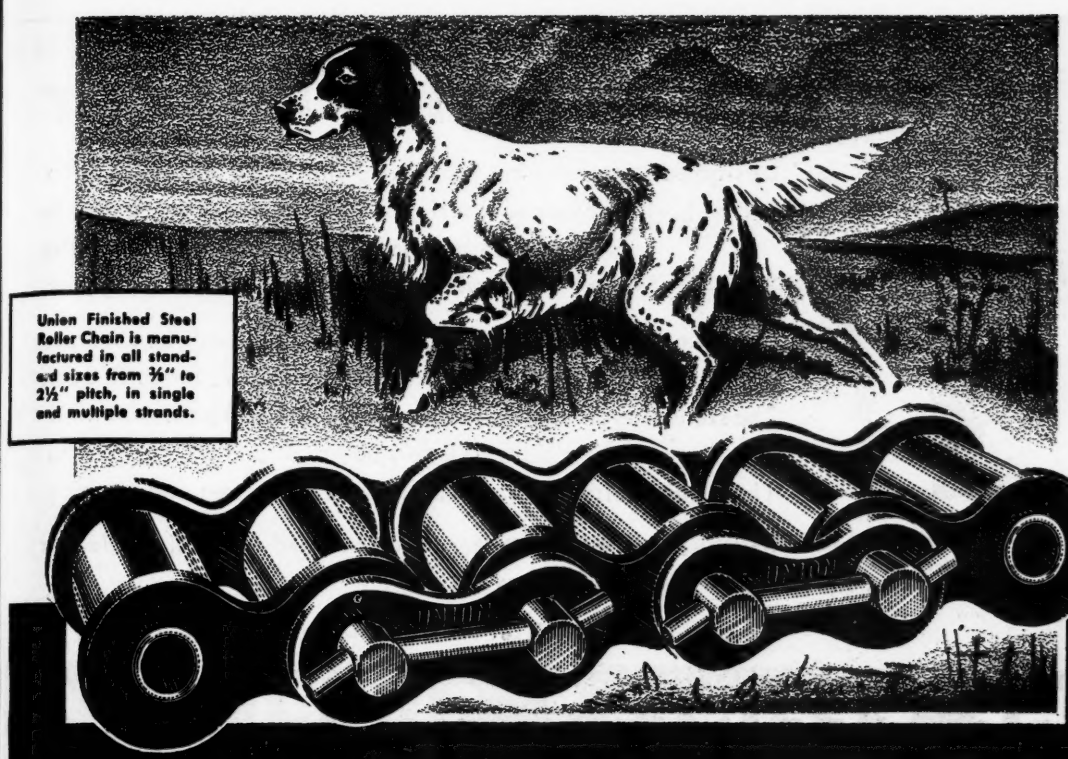

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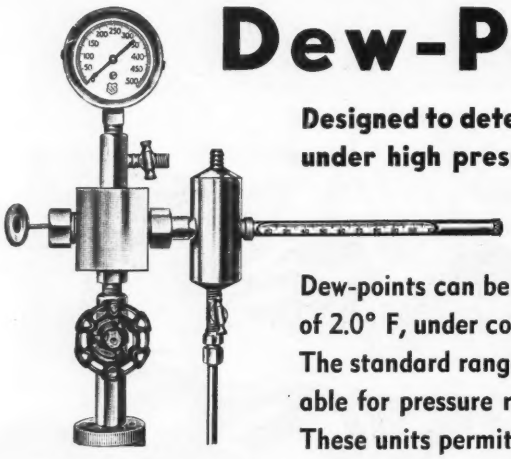

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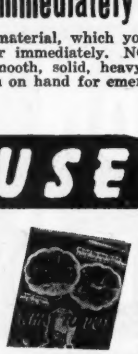

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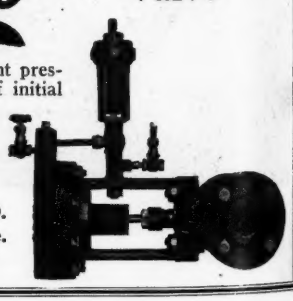

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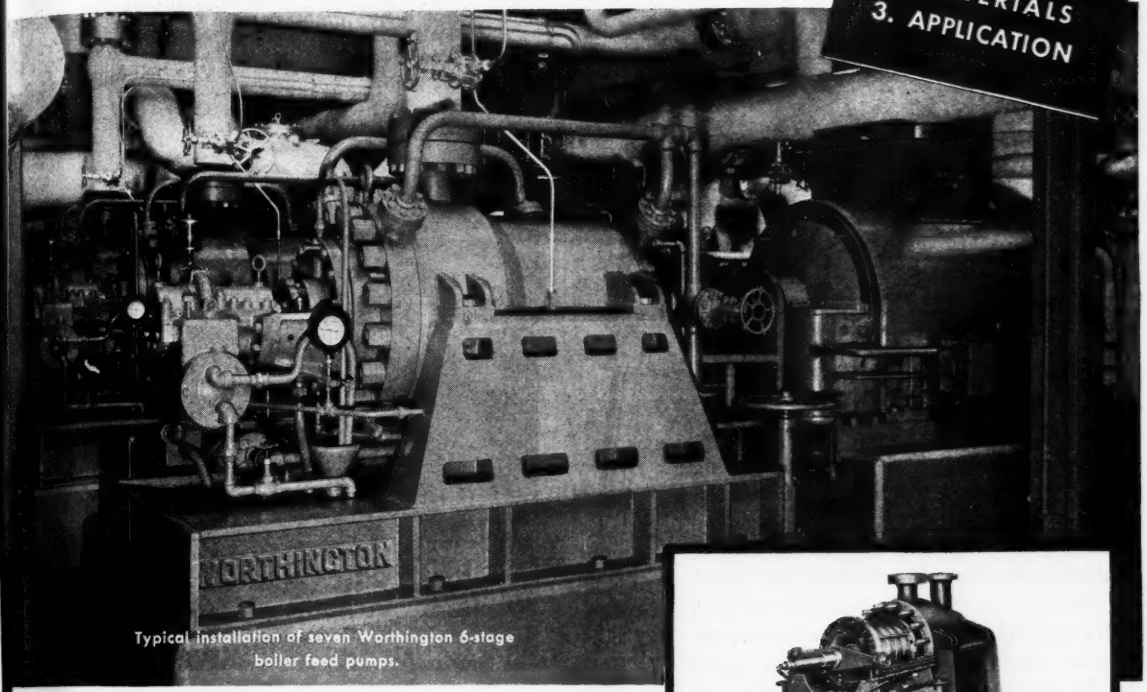

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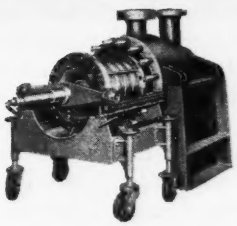

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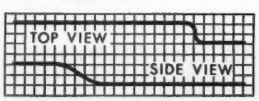

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Yarnall-Waring Co. 10-11, 68, 139

Zurn Mfg. Co., J. A. *

Firms whose advertising is not in this issue but is appearing in other issues are marked with an *

Many "Special" Valves are found in

CHAPMAN'S *Standard* LINE

Whenever you have a valve problem, first look through Chapman's Standard line. Many seemingly special valves will be found among our products. For, over the years, as we have designed new valves and fittings, we have added many of them to our line of "Standards." Today this line includes many unusual types and sizes in steel, iron and bronze alloys.

If a special type of valve *is* required, our Engineering Department will be glad to help you with its development.

The
CHAPMAN VALVE
Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS

"WITH PERMUTIT-CONDITIONED WATER NOW IT'S

Full Steam Ahead!"

How Permutit protects boilers against scale and corrosion . . .

There's no boiler scale or corrosion to slow down production in the plant that's Permutit* protected. Permutit Water Conditioning removes the impurities in boiler feedwater *before it enters the boilers.*

Among Permutit processes for control of water quality, power plants favor particularly the Zeo Karb* Water Softener (right), Hot and Cold Lime Soda Softeners, Deaerating Heaters, Continuous Blowoff and Demineralizers that deliver a low-cost substitute for evaporated water.

Why risk damage to critical equipment and even possible shutdowns? Make it "full steam ahead" instead, with Permutit-Conditioned water. Write us about your water problem. Address The Permutit Co., Dept. A1, 330 West 42nd Street, New York 18, N. Y. or Permutit Co. of Canada, Ltd., Montreal.

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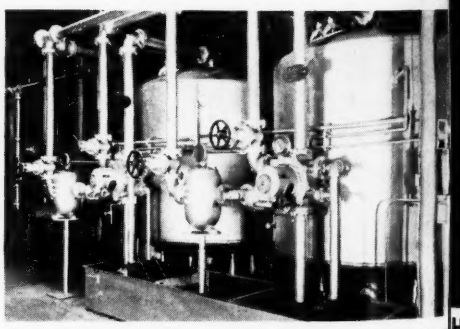

PERMUTIT ZEO-KARB* H WATER CONDITIONER removes both hardness and bicarbonates from water. Effluent contains no incrustants, is reduced in total solids and alkalinity. Alkalinity can be adjusted by mixing effluents from a Zeo-Karb H unit and a sodium zeolite unit.

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PERMUTIT

Manufacturers of ALL types of water treatment equipment

It's good business to begin with Good Water

WATER CONDITIONING HEADQUARTERS